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The SCIENTIFIC MONTHLY

March 1944

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founding and Organization

In 1848, on September 20, the Association was formally organized and held its first meeting; in 1874 it was incorporated under the laws of the Commonwealth of Massachusetts and given the right to receive, purchase, hold and convey property. Its governing body is a Council, now having 255 members.

The Association is national in scope, with membership open to the whole world on equal terms, and its interests include the broad fields of the natural and the social sciences. Its varied activities are carried on under 16 sections with which 189 affiliated and associated societies, having a combined membership of nearly a million, cooperate in organizing programs for its meetings.

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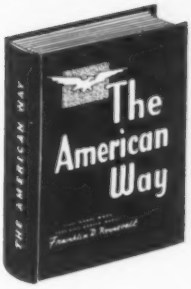
A world torn by conflicts and fearful of the future is looking more and more toward scientists for leadership. The opportunity for unparalleled service is theirs and the fact that they have available the only essentially new methods, if not purposes, imposes an equal responsibility. For these reasons it will be the Association's steadfast purpose to promote closer relations among the natural and the social scientists, and between all scientists and other persons with similar aspirations, to the end that they together may discover means of attaining an orderliness in human relations comparable to that which they find in the natural world about them.

MEET THE AUTHORS

P. S. TANG (Tang, Pei-sung), Ph.D., is the director of the Physiological Laboratory, Agricultural Research Institute, National Tsinghua University, Kunming, China. His "Philosophy of Agriculture" was brought to our attention by his friend, C. K. Tseng (see *The Scientific Monthly* for January, 1944, p. iv), who, unfortunately, could not supply a recent photograph of the author. Dr. Tang is the son of a distinguished educator, who was a cabinet member in the Chinese Republic. He was born in 1903 in Kishui, Hupeh, China, received his early education in Peking and Tokyo, and was graduated from Tsinghua College in Peking. Coming to the United States in 1925, he took a bachelor's degree at the University of Minnesota and received his doctor's degree in plant physiology at The Johns Hopkins University in 1930. Then followed three years of post-doctorate research in the Laboratory of General Physiology at Harvard University, with summers at the Woods Hole Marine Biological Laboratory. In 1933 he returned to China to teach plant physiology at the National Wuhan University, Wuchang. In 1937 he became professor of biochemistry at the National Kweiyang Medical College and in 1939 began his present work.

NORMAN TAYLOR is the director of the Cinchona Products Institute, Rockefeller Plaza, New York City. He was born in England but has long been an American citizen. He has been an assistant at the New York Botanical Garden and later a curator at the Brooklyn Botanic Garden. His present work is devoted to research and education in quinine and other alkaloids of *Cinchona*. Mr. Taylor has published scientific papers on ecology and plant geography and more recently on *Cinchona* (see *The Scientific Monthly*, July, 1943, p. 17). He served as editor for botany and ornamental horticulture of the most recent edition of Webster's Dictionary. Among his published books are *Botany: the Science of Plant Life*, *A Guide to the Wild Flowers*, and *The Garden Dictionary*. For the last the Massachusetts Horticultural Society awarded him their Gold Medal and referred to it as "The most notable horticultural book of recent years." His article in this issue is a chapter of his forthcoming book, *The Flight from Reality*.

The American Way



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MEET THE AUTHORS, Continued

WALTER HENRICKS HODGE, Ph.D., has taken leave from the staff of the Department of Botany, Massachusetts State College, to serve as field botanist with the FEA, Office of Economic Warfare. He is searching for new stands of *Cinchona* (for quinine) in the mountain forests of Peru. Dr. Hodge was born in Worcester, Massachusetts, in 1912 and was educated at Clark University, Massachusetts State College, and Harvard. At Harvard's Gray Herbarium he was a teaching fellow from 1938–41. During this period he made his floristic studies in Dominica and also in Cuba at the Harvard Tropical Station near Cienfuegos. At other times he has botanized in the region of James Bay, Canada, and in the Shickshock mountains of the Gaspé Peninsula. His interest in travel, photography, and writing is displayed in his Dominica Diary. Under the name of Henricks Hodge he is a writer of popular articles on natural history.

F. J. CHAMPION is a staff writer—and a good one—of the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, Madison, Wisconsin. As he is publicizing the work of many investigators in his article on the new technology of wood, it seems appropriate here to introduce the Forest Products Laboratory (below) instead of the author. The Laboratory, founded in 1910 in cooperation with the University of Wisconsin, is devoted entirely to investigation of wood products and their manifold uses in modern civilization. Its research program ranges from the forest to the manufacturing plant and deals chiefly with the production of paper, lumber, plywood, and wood chemicals.

NEW BOOKS

An Introduction to Pollen Analysis. G. ERDTMAN. Ill. xvi + 240 pp. 1943. $5.00. Chronica Botanica.

Volume 12 of "A New Series of Plant Science Books," edited by Frans Verdoorn, is largely a study of the morphology of the pollen grains of angiosperms and gymnosperms, and of the spores of ferns. Both fossil and living materials are included. Several hundred drawings make this an indispensable reference book.

Society and Nature. HANS KELSEN. viii + 391 pp. Dec., 1943. $4.00. The University of Chicago.

This is a sociological study of the relationship between the principle of retribution, as one of primitive man's fundamental social interpretations of nature, and the idea of causality which developed from that interpretation. It closes by showing that today society is, from the viewpoint of science, a part of nature.

The Contribution of Holland to the Sciences. Edited by A. J. BARNOUW and B. LANDHEER. Ill. xviii + 374 pp. 1943. $3.50. Querido.

The vast contribution of the Netherlands people to the scientific and cultural advancement of the world is amply demonstrated in this collection of twenty articles, each by an expert in his field. The book is divided into two parts, one on the humanities and social sciences, another on the exact sciences and architecture.

The Life and Works of the Honourable Robert Boyle. LOUIS TRENCHARD MORE. xii + 313 pp. Feb., 1944. $4.50. Oxford University.

Professor More's biography of Boyle, one of the great pioneers of science, not only provides the only adequate book on this 17th century theologian, alchemist, and chemist, but also enlivens an important creative period in history that spanned the Middle Ages and the new world of rational knowledge.

Edible Wild Plants of Eastern North America. M. L. FERNALD and A. C. KINSEY. Ill. xiv + 452 pp. 1943. $3.00. Idlewild.

This is a unique guide to all edible flowering plants and ferns, some important mushrooms, seaweeds, and lichens growing wild east of the Great Plains and Hudson Bay and north of Peninsular Florida. It includes delightful menus and rare recipes for such dainties as escalloped roots of goat's-beard. Poisonous plants are indicated.

The Floor of the Ocean. REGINALD ALDWORTH DALY. Ill. x + 177 pp. 1942. $2.50. Chapel Hill.

Professor Daly, of Harvard, plumbs the mysteries of ocean geology, maintaining that to a large extent the secrets of land geology are hidden under the ocean. He discusses the "underpinning" of the ocean, the vast chains of submarine mountains, the continental slopes, the deep-sea volcanoes, pointing out various detective methods and results.

Rising Above Color. Edited by PHILIP HENRY LOTZ. viii + 112 pp. 1943. $1.50. Association Press; Revell.

The characters and achievements of thirteen distinguished Negro personalities are sketched in this little volume edited by a Methodist pastor at Toulon, Illinois. This book should, as intended, "promote a finer appreciation of the Negro and his contribution to American life and civilization."

MEET THE AUTHORS, Continued

HARLAN T. STETSON, Ph.D., is director of the Laboratory for Cosmic Terrestrial Research, a new laboratory established by him at Needham, Massachusetts, in connection with the Massachusetts Institute of Technology. The story of the Laboratory and its work is told on pages 207–217 of this issue. Dr. Stetson is a native of Massachusetts, having been born in Haverhill in 1885. He studied at Brown, Dartmouth, and Chicago; taught physics at Dartmouth, physics and astronomy at Northwestern, and astronomy at Harvard, Ohio Wesleyan, and Ohio State. While in Ohio he was director of the Perkins Observatory near the town of Delaware. There he put into operation a 69-inch telescope. Since 1936 he has been associated with M.I.T. He has published many scientific papers. His books are entitled: *A Manual of Laboratory Astronomy*, *Man and the Stars*, *Earth, Radio and the Stars*, *Sunspots and Their Effects*, and *Map Reading and Avigation*, the last with R. M. Field. He has traveled over 60,000 miles on six solar expeditions and is an experienced deep-sea yachtsman and navigator.

JAY C. KNODE, Ph.D., Dean of the College of Arts and Sciences of the University of New Mexico, is on leave in Washington, D. C., with the United States Office of Education, studying post-war problems and helping to organize conferences for their consideration among American colleges and universities. He knows education from bottom to top and the country over. Space is lacking to name the schools at which he studied and taught but it must be said that he took his doctorate at Columbia. Two years ago Dr. Knode visited 31 State Universities and published some of his observations last year. His study of presidential trends, in this issue, also grew out of his "busman's holiday." His book, *Foundations of an American Philosophy of Education*, was published in 1942. Mountain trout fishing, photography, and golf are his hobbies.

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MEET THE AUTHORS, Continued

W. L. McATEE, M.A., is a prominent Technical Adviser of the Wildlife Service (Department of the Interior), Merchandise Mart, Chicago, Illinois. He was born in Jalapa, Indiana, in 1883 and studied at Indiana University where he became a disciple of Dr. C. H. Eigenmann, one of the leading zoologists of the world in his time. Eigenmann set an example of rigorous personal research that has been followed ever since by many of his devoted students. Mr. McAtee joined the old Biological Survey of the U. S. Department of Agriculture in 1904 (now the Wildlife Service) and was further influenced by Professor F. E. L. Beal, the world's greatest economic ornithologist. Preferring the byways to the highways of science, Mr. McAtee made his reputation both in economic ornithology and in systematic entomology. He is interested also in the vernacular names of birds. Addicted to writing, he has published more than 700 technical papers and a great many more of a strictly literary nature. He delights in combating nature fakers.

DONALD PIERSON, Ph.D., is Professor of Sociology and Social Anthropology in the Escola Livre de Sociologia e Politica, São Paulo, Brazil. He was born in Indianapolis, Indiana, in 1900 and studied at the College of Emporia (Kansas) and The University of Chicago. While a research assistant at Chicago he made his first acquaintance with sociological problems in Brazil at Bahia. His *Negroes in Brazil: A Study of Race Contact at Bahia* received the Anisfield Award for "the most significant book of 1942 on race relations in the contemporary world." After an interlude at Fisk University he was invited in 1939 to return to Brazil to give courses and train research personnel at the Escola Livre. Some young Brazilians whom he has helped to train in the social sciences will join him in cooperative research. Later Dr. Pierson hopes to study the results of race contacts in centers of Portuguese expansion outside of Brazil.

MEET THE AUTHORS, Continued

HARRISON HALE, Ph.D., LL.D., head of the Department of Chemistry at the University of Arkansas, was born in Columbus, Mississippi, in 1879. He studied at Emory University and took his graduate work at Chicago under Julius Stieglitz and at Pennsylvania under Edgar Fahs Smith. He taught at Drury College until 1918 when he went to Arkansas. Dr. Hale has many of the characteristics of his eminent preceptor at Pennsylvania. Like Provost Smith, he has developed a large chemical family of his former students to whom he sends letters each year. Furthermore, he is interested in the history of chemistry and in the civic responsibilities of chemists. As examples of his activities: he is secretary of the Arkansas Water and Sewage Conference, chairman of the Division of the History of Chemistry of the American Chemical Society, teacher of a large men's Sunday school class, past president of the Fayetteville Chamber of Commerce and Scout Council—a citizen of credit and renown. He has published a little book, *American Chemistry*, and hopes that some plan may be worked out to prepare a thorough and comprehensive history of chemistry in the United States.

GEORGE R. DAVIES, Ph.D., is Professor of Business Statistics in the College of Commerce at the State University of Iowa and editor of the *Iowa Business Digest*, a monthly report sent out to business men. He was born in Abingdon, England, the son of a Protestant minister. In his tenth year his parents brought him to the Dakota frontier where he grew up. His undergraduate work was done in Des Moines, Iowa, and his graduate work at the University of North Dakota under John M. Gillette and Frank L. McVey, and at Wisconsin under E. A. Ross and Lester F. Ward. He taught at Princeton and the University of North Dakota and went to the University of Iowa in 1928. Outside his immediate field of work he is chiefly interested in social evolution, particularly in its economic aspects.

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THE SCIENTIFIC MONTHLY

MARCH, 1944

HELIOS AND PROMETHEUS: A PHILOSOPHY OF AGRICULTURE

By PEI-SUNG TANG

LIFE denotes activity, and activity incurs the expenditure of energy. In man, the energy for his activities is derived from the consumption of food which is manufactured for him directly or indirectly by the green plant. When primitive man lives in the forest, supported by the fruits of its vegetation and deriving warmth from firewood, he is, figuratively speaking, a parasite. When gradually he learns the usefulness of certain kinds of plants and animals for food and fuel and singles them out for cultivation, propagation, and protection, he initiates the art of agriculture, emerging, we may say, from the state of parasitism to that of symbiosis.

While man and animals derive their food and fuel from the green plant, the latter is not the ultimate source of energy. It in turn obtains its energy from the sun through a unique process known as photosynthesis. This process, whereby the radiant energy of the sun is converted into chemical energy available to plant, animal, and man alike, is the fundamental reaction on which the existence of all higher forms of life depends, and on which is built man's art of agriculture. All the efforts of the practical farmer and of the agricultural scientist are directed, whether consciously or unconsciously, toward increasing the efficiency of certain green plants in the performance of this all-important function, directly or indirectly.

How is the sun's energy transformed through the plant into forms available to man? The green plant, with its characteristic pigments, converts carbon dioxide and water into sugar and other forms of organic material, thereby trapping, so to speak, radiant energy and changing it into chemical energy in food and fuel which, when consumed by man, supply him with energy for his activities. The process is at once simple and complicated. It is simple because water, sugar, and carbon dioxide are common stuffs of nature. That it is complicated we may infer from the fact that, in spite of all the efforts of the biologists and chemists, we are still ignorant of the mechanism of this process, let alone the ability to duplicate and control it in the laboratory.

Important as are such agricultural processes as the improvement of crops, animals, soils, or silviculture, and the prevention of diseases, they are merely means of improving a process on which man is dependent, but which he is unable to duplicate and control at his will. In the cosmic cycle of energy transformation, the green plant can very well be independent of man, but man cannot be independent of the green plant. The fundamental problem of human food producduction, from the biological point of view, is that of duplicating the process of photosynthesis in the laboratory, independent of the living plant. When that time comes, man will be freed from the grueling labors of agriculture and the cruel uncertainties of the elements. Before that stage of scientific development is reached, however, man will still have to rely on the green plant as the transformer of solar energy into forms available to himself. He is not only constantly subjected to the Malthusian struggle between himself and his fellow men; he is also involved in a four-sided competition for land area among the plant, the animal, the machine, and himself.

Plant and Man

Civilized man, although he has long abandoned his worship of the fire and the sun, is not much further advanced than his ancestors; he is still shrouded in the mysteries of the fundamental relation between the sun, the green plant, and himself. Until the time when he can reproduce this apparently simple process of photosynthesis in his laboratory, independently of the green plant, man cannot claim to be free from the vestiges of his ancestral sun and fire worship. When that day comes, the energy awaiting his disposal will be enormous.

The tremendous amount of radiant energy falling on the earth's surface is hard for us to conceive. It is estimated that one square meter of the earth's surface receives from the sun the equivalent of about one horsepower, and the total radiant energy intercepted by some 200 million square miles of earth's surface is, at this rate, equivalent to 200 trillion tons of anthracite coal per year, which is 200,000 times our annual coal consumption. This amount of energy is equivalent to the total food requirement, in terms of heat value, of the entire world population for one million years! Or, putting it in another way, the radiant energy received on one thousand square miles of land in a growing season of 90 days, if all converted into food, would be sufficient for the heat energy required for the existence of the entire population of the world for one year.

Of this enormous amount of energy falling on the surface of the earth, how much is actually made available for human consumption by the green plant? When the entire plant is considered, not limiting ourselves to the portions used for food by man, only 0.5 percent of the solar energy falling on the sunflower plant is stored in the organic matter. For wheat, rye, and potatoes the figure is 3 percent; for corn it is 2 percent. In the case of forest trees, calculations show that for the redwood of California the efficiency is only 0.3 percent, and for the Eucalyptus tree it is around 0.5 percent. When only the edible portions of the crop plants are considered, the energy yield per acre, as calculated from records taken both in China and in the United States, are as follows: Indian corn, 2.6 million calories; wheat and barley, 1.6; field peas, 1.2; rice, 3.6; and Irish potatoes, 3.0. When compared to the solar energy received on one acre of land during a growing season of 90 days, which amounts to approximately 2 billion calories, these figures are only of the order of thousandths parts of the total radiant energy intercepted on the land surface during a growing season. And all the labors of the farmer, all the efforts of the agriculturalists, are directed only toward increasing the efficiency of certain plants in the utilization of these thousandths parts of energy of the sun intercepted by the earth!

The practice of agriculture, whereby the sun's energy is stored in food and fuel through the cultivation of green plants, is a very wasteful process of utilizing solar energy from the standpoint of cosmic relations between man, the green plant, and the sun. However, from the anthropocentric standpoint, this practice, wasteful as it is, is still a profitable proposition. Man, in the cultivation of his land, is only building a dam, so to speak, to guide a very minute portion of the otherwise untamed torrent of ever degrading energy from the sun into channels for the performance of useful work, much as a minor part of the wasted energies of the Niagara Falls is used for the production of electricity. Regardless of man's existence, the sun forever emits radiant energy in its process of degradation, and man's part is only in the capturing of an insignificant fraction of this degrading energy into useful work. The amount of labor expended in building and caring for the dam is the labor which man puts in for the cultivation and protection of the crop plants and farm animals, which is relatively small compared to the energy gained from his efforts.

For the cultivation of an acre of corn, 23 man-days are required in China as against 2.5 man-days in the United States. For the cultivation of winter wheat, the respective figures are 26 and 1.2, and for the cultivation of an acre of rice, 82 man-days are required in China. Assuming an average of 3,500 calories per day per capita for the food consumption of the farmer, the energy expenditures are: for corn, 80,000 for the Chinese and 8,800 for the American. For winter wheat, they are: 91,000 for the Chinese and

4,200 for the American. For the cultivation of an acre of rice, the Chinese farmer puts in an amount of labor equivalent to 290,000 calories. For these amounts of energy put in, an average yield of 2 million calories per acre is realized, resulting in the apparent gain of energy from 7 to 25 times for the Chinese, and from 200 to 500 times for the American.

The low energy input for the Americans is misleading. Actually, he may have put in more energy in the form of motor fuel than the Chinese farmer, so that in terms of gross energy input, he may even have to put in more energy in the cultivation of an acre of land than the Chinese. But, in terms of human labor, the amount which the American farmer puts in is very small, and the extra human labor thus saved could be used for the production of items which enable him to lead a more luxurious form of life and to build his art and culture, which cannot be measured in terms of energy.

Animal and Man

There are two major uses for which animals may be employed by man: power and food. While man may survive on a vegetarian diet alone, it is generally agreed among nutritionists that a people fed on a generous supply of animal proteins are as a whole healthier and more aggressive than those who survive mainly on a vegetable diet. According to this view, an ample supply of animal food should be one of the chief objectives of agriculture. And yet, at least half of the people on earth are deprived of this privilege. Aside from religious considerations, which in the final analysis may still be due to economic pressure, the reason is simple. As long as animals are, like man, dependent on the green plant for food, animal products are always more expensive than plant products. In obtaining his food indirectly from the plant via the animal, man has to pay the price of the middleman. The amount of land required to support one dairy cow in the United States varies from one to 10 acres, and on the average, let us say, 2 acres, obtaining thereby 1,350,000 calories in the form of milk, which amounts to 675,000 calories per acre as against some 4 million calories obtainable from the two crops of grains and potatoes produced thereon. The contrast is even more marked when the land is devoted to the raising of beef cattle and poultry. One acre of land produces only 0.21 million calories in the form of eggs, and 0.1 million calories in the form of beef. In order that every country may reach a dietary standard similar to that of the United States, the animal products of the world would have to be at least doubled, which would in turn require a twofold increase in the area of pasture-land as existent today. And this increase in pasture-land would cause a diminishing of crop land corresponding to about 15 times its size, since one acre of land devoted to the production of grains yields 6 to 7 times as much food energy as that devoted to the raising of dairy cattle.

So long as the population of the world does not decrease, so long as the present practice of agriculture cannot be expected to give significant increase in crop yield, the competition between man, animal, and plant for land area will forever be a barrier to providing ample animal products for human consumption.

In his ascent from parasitism to symbiosis, man domesticated animals to supply power for his farm, thus ridding himself of the heavier burdens. As man becomes more and more civilized, the animal is in turn replaced by the machine. How does the animal compare with the gas engine as a converter of energy? For muscular work in man and animals, a gross efficiency of 25 percent may be realized. That is, of the amount of energy in the form of food given to the animals, 25 percent of it may be realized in the performance of work, which is about the best that a diesel engine can do. For the working animal, however, over a period of 24 hours, the efficiency is considerably lower, and is of the order of 10 percent. But even this low figure is better than the performance of the steam engine, which is only 7 percent efficient, and is equal to the performance of the gas engine. Based on these figures, the draft horse is at least as efficient a "machine" as the tractor. To this must be added the advantages possessed by the horse: the ability to repair itself, to respond to changing rates of performance within short periods, and the possession of a certain degree of intelligence.

For this reason, the animal is a better source of farm power in densely populated countries with small farm holdings, such as in China, India, and Japan.

If the animal possesses so many advantages over the gas engine, and is at least as efficient in the performance of work, why is the animal being extensively replaced by the gas engine in some countries such as in the United States? The answer lies again in the competition between plant, animal, and man for land surface. While the animal is as efficient as the gas engine, the former, being dependent on plants for fuel, must rely on land area for its maintenance so that a part of the land it helps to cultivate goes to the maintenance of itself. Evidently the animal is not suited for large-scale operations in which case the proportion of land area devoted to the maintenance of the animals may become a serious economic factor. On the other hand, the gas engine consumes fuel in concentrated form, transported to the farm from a single oil well on perhaps an acre of land from which is supplied the fuel for thousands of farms. In a country rich in mineral oil, the horse is no competitor with the gas engine. Conversely, in a country without oil resources, though the land holdings may be large, mechanization of agriculture is not necessarily economical even when power alcohol may supply the fuel for the machines, since alcohol comes from the plant, which in turn requires large land surfaces for its cultivation.

Machine and Man

As the domestication of plants and animals distinguished the age of agriculture, so does the utilization of land for the fuel of the machine characterize the age of industry. The power and raw materials of industry come from two sources, the organic and the inorganic. Of all the sources of fuel for power, coal and oil remain the cheapest, and certainly the most generally employed, not excluding water power. While coal and petroleum are generally classified as minerals, they are of organic origin deposited for us in the geological ages. Being of organic origin, they are subjected to the same drawbacks as the agricultural products; that is, the energy stored therein is only an insignificant fraction of the radiant energy which was available to them. At any rate, the world's supply of coal and petroleum is limited by the extent of their deposition on the one hand, and the enormous time required for their formation on the other. The world's known, readily available petroleum deposits may serve us for some thirty-five years at the present rate of consumption, while the coal deposits of the world can last for some six thousand years. What about relying on the land for the production of fuel for the machine? Of late, much emphasis has been given to this problem, both in the United States and in China. In the United States, the movement was originated by the Farm Chemurgists for the utilization of farm surplus. In China, the movement was initiated out of dire necessity. An analysis of the problem will make it clear that such a practice would involve competition between man and machine for land area, and while under special conditions a small part of the fuel may be derived from the land, in the long run the practice of obtaining fuel from farm land for the machine has no great future.

Let us take first the case of a country like the United States. An oil well on an acre of land, say in Oklahoma, may have an ultimate production of 3,500 barrels of crude oil, yielding 1,000 barrels of gasoline. The same acre, if planted to corn, would only give a quantity of alcohol equivalent to three barrels of gasoline. At this rate, three hundred years are required for the same acre of land to produce fuel in the form of power alcohol as compared to the five to ten years for the production of gasoline. True, that acre of land can be used over and over again for the production of power alcohol if so desired, while the petroleum deposit will ultimately be exhausted. But three hundred years is a long time to wait for the economic functioning of the machines. Furthermore, as some writers put it, a surplus of one billion bushels of corn would sound tremendous to the farmer, but it would only yield 250 million gallons of alcohol, enough to run U. S. cars and trucks for about three weeks.

So much for the possibilities of obtaining power from land in a country with agricultural surpluses. Let us turn now to the problem in a country which, out of dire

necessity, is resorting to the use of power alcohol for the functioning of her war machine. Economists, chemists, and militarists of China have urged the use of power alcohol for China's motor vehicles, and plant after plant has been set up for the production of this material during the six years of China's war with Japan. The irony of this lies in the fact that such a practice, if on an extensive scale, will force the Chinese to choose between starving the trucks or starving themselves. Assuming a total of 25,000 cars and trucks running per day, the amount of alcohol consumed, on the basis of 30 gallons per car, would be equivalent to 7,500 acres of land area, making a liberal allowance of 100 gallons of alcohol per acre. For the year, the land area required would be 2,700,000 acres, which is roughly one percent of the total cultivated area of all China, and is about six percent of the total cultivated area in "free China," the food production of which is barely sufficient for human consumption.

The matter may be different in peacetime China. The import of gasoline to China in 1932 was about 3 million gallons, equivalent to 5 million gallons of alcohol which would require a land area of 50,000 acres, which is only 0.2 percent of the total cultivated area of China. Even if the gasoline consumption should be increased five times more than the pre-war figure, the amount of land required for the production of power alcohol is only of the order of one percent of the total cultivated area. If a mixture of alcohol and gasoline is used, the land area required can further be reduced.

For a country relatively undeveloped industrially, and for a country with food surplus but without petroleum resources, power alcohol may be a temporary solution to the fuel problem. But, as industry is developed, competition results, sooner or later, not only between man and machine for fuel and food, but also between one machine and another.

From these considerations, the power problem cannot be solved by the utilization of farm land for the production of power alcohol, or vegetable oil, or any such products, but the solution has to be made independent of the land. The more immediate solution is, of course, the hydrogenation of coal, and the extended use of hydroelectric power, but the ultimate solution will perhaps lie in the direct utilization of the sun's energy and in the harnessing of energy from the disintegration of atoms.

Man as Agriculturalist and as Industrialist

If the land is not to be relied upon for the power of the machines, can it be relied upon ultimately for the production of raw materials? The answer to this question depends on the kind of raw material and the length of time to be considered. As man advances from the agriculturalist to the industrialist and emerges into the age of science and technology, he continuously attempts to free himself of the limitations imposed upon him by the land and by the elements. He is forever striving to be independent of the land for the production of raw materials for his machine. In this quest for independence, man is making much use of the discoveries in his laboratory; because of this dependence of technology on the advance of science, the latter is the factor deciding whether certain raw materials may be produced synthetically or whether the land should continue to supply them. Within the last generation, man has been successful in a number of attempts in this direction, and in a very small measure he has even succeeded in the attempt to create an artificial environment for himself in weather-conditioned dwellings. He has been successful in the synthetic production of indigo out of mineral sources, in the fixation of atmospheric nitrogen, and in the large-scale manufacture of synthetic rubber. He has been particularly successful in the production of artificial fiber, rayon, and more recently, nylon, and a host of similar products which threaten to displace natural silk from the market. Is this tendency to replace agricultural products by synthetics a temporary and ephemeral boom or is it likely to continue and increase? We shall examine the future of natural silk against synthetics and that of the tung oil as examples.

For the production of 40 million kilograms (88 million lbs.) of silk, which was the total world production for 1935, 2 million acres of land are required for the cultivation of mulberry trees, which in turn requires in a

country like China, the amount of labor equivalent to 400 million man-days. To this must be added 20 million man-days for the care of the worms and 80 million man-days for processing. The land and labor involved are equivalent to having the entire population of Philadelphia working in the State of Delaware for the year round on the production of natural silk alone, while a chemical plant on a city block of space in Wilmington, employing a few hundred men, may turn out an equal quantity of synthetic nylon during the same time, leaving the enormous surplus of land and man for the production of other articles of industry, and for the attainment of a richer way of life.

Add to these considerations the uncertainties of the elements, of diseases and epidemics, and the difficulties involved in obtaining products of uniform quality, it is evident that the future of silk as against artificial fibers is not encouraging. But this does not mean that there is no room for the production of a limited amount of natural silk in countries with a dense population, and for countries which are less industrially developed. As a handicraft, on a family production scale, natural silk will still have its place in the near future and may still have a market in the more industrially developed countries, as an item of novelty and luxury. But the future of natural silk as an industry on any large scale is doomed.

On the other side of the question, there is the example of tung oil, which has long been a Chinese monopoly. In recent years, experimental plantations were made in the southern part of the United States without much success. In spite of the optimism of the small group of landowners along the gulf coast, the concensus of expert opinion is perhaps not in favor of the attempt. The urgent need of the oil and the difficulties in obtaining the product, especially during the past few years, have forced chemists to adopt substitutes for tung oil, mainly with processed castor oil. But the problem is far from being solved. In so far as the substitute comes from the land, as does castor oil, it suffers the same drawback as does the product which is being substituted. While the treated castor oil or any other oil such as oiticica oil may even possess advantages over tung oil in certain particular aspects, they cannot be entirely satisfactory as substitutes for the general use to which tung oil is being put. Besides, these oils have other uses than as tung oil substitutes, in their own right, and the limited area of Brazil and other South American countries cannot be entirely devoted to the production of vegetable oil alone.

Man, in his transition from the savage to the farmer, learned the use of land for the production of food for his activities and fuel for his home. As he passed from an agriculturalist to an industrialist, he made additional use of his land for the production of power and raw material for his machines. Man is now on the verge of a new era, the age of technology, and is gradually learning, through his better understanding of nature, to obtain power and raw material directly from the inorganic elements through chemical processes, independent of the green plant. The thoroughness with which synthetic materials can replace agricultural products depends on two factors, the advance of man's scientific knowledge and the balance among many economic factors. At least in the near future, the replacement cannot be complete, and it is doubtful whether it ever can be complete, but the trend of progress is clear: for his industrial raw materials man is trying to rely more and more on synthetic materials out of air, water, and minerals, instead of relying on plants and animals.

Alchemy and Utopia

If the tilling of land is symbolic of man's attempt to make fuller use of nature's gift, the toil of the alchemist marks the beginning of man's attempt to conquer his environment. And the remarkable progress made in the fields of science during the present century is the beginning of the fulfillment of the dreams of the alchemists. During the last decade or so, one discovery in the field of nuclear physics led into another, making possible artificial radioactivity and the transmutation of the elements and culminating in the practical application of the cyclotron, popularly known as the atom smasher. The modern alchemist is not only able to fulfill the dreams of his predecessors, that of transforming quicksilver into gold, he has gone

far beyond. He has at his disposal means of unleashing energy from the atoms, which in time may be turned into practical application, furnishing sources of power for the machine independent of the green plant. This tool of the modern alchemist, though still in the stage of the dynamo in Faraday's day, promises to be of far more value to himself than was Midas' gold.

The chemist, in his search for the secrets of matter, has produced materials of synthetic origin with which we are clothing and housing ourselves. The significance of these developments is far greater than the mere satisfying of human curiosity or the providing of man with a greater variety of materials for his frivolities. These discoveries herald the beginning of a new era much as the cultivation of the first grain of rice, or the introduction of the steam engine or the dynamo; they usher in the era of technology in which man may hope to be at least partly independent of the green plant (hence of land surface) for the supply of his raw materials as well as for the production of his food and power. We have seen the displacement of the indigo plant by synthetics of mineral origin, the capturing of atmospheric nitrogen independent of the plant and animal, and the very rapid substitution of artificial fibers for silk, wool, and even cotton, within the last few years. The time may not be far off when rubber plantations will give way to factories manufacturing synthetic rubbers, and when certain other agricultural products will be replaced by such materials as plastics and fiber glass.

Already the biochemists and the physiologists are isolating and even synthesizing for us vitamins and hormones which less than a decade ago were known to the layman only as letters of the alphabet. It is not mere wishful thinking that in the generation that lies ahead of us, we may understand enough about the fundamental process of photosynthesis of the green plant to be hopeful of liberating ourselves some day from the toil of agriculture as practiced now. Already much emphasis is being placed in this branch of biological research. The establishment of laboratories for photosynthesis at the Carnegie Institution and more recently at the Kettering Foundation, the groups of biologists, chemists, and physicists at Chicago and California cooperating on the investigations into carbon assimilation by the green plant and by bacteria, are evidences of growing interest in the problem of photosynthesis in America. Already great strides have been made in the last few years, and the time is not far off when we can be much better informed about the mechanisms of this process than we are now.

When that time comes, man will be independent of the limited two dimensional land area for the cultivation of his crops for food and power. He may, by using the earth as his crucible, the sun and the atoms as his furnace, and the air, soil, and oceans as his reagents, elevate himself from slavery to the status of a Titan. Man will then enjoy an age of abundance and prosperity, free from muscular labor and strife. He will be given a respite from his constant fight against his crops, his animals, and his machine for the limited land area. Until that time comes, however, man will still have to depend on agriculture as practiced at present for food and power. He will still not be freed from the constant struggle for space. This struggle can, however, be alleviated temporarily in certain ways, aside from the usual practice of improving the soil, crops, cattle, and the prevention of diseases, and the much advocated limitations on population growth. One of these is the more extended use of the seas and oceans in which are stored vast wealths of animals and plants, and about which the young science of oceanography may have much to tell us in the future. Another possible measure for the more economic use of land lies in the establishment of a world state in which a scientific and rational regionalization of agriculture may result in a more efficient production of agricultural products through fuller utilization of the natural distribution of climate and soils of the world, unlimited by artificial political boundaries between the nations.

COME AND EXPEL THE GREEN PAIN

By NORMAN TAYLOR

SCARCELY forty years after Montezuma lost his empire to Cortes, the Church in Mexico began to worry about two rather disturbing phases of what the priests called Aztec idolatry. The Spaniards had been even more horror-stricken at the hecatombs of "ritual murders" on the *teocalli*. For under those extraordinary pyramids they found the enormity of this Aztec fanaticism, whose priests measured their zeal by the number of their victims' skulls. While the Conquest had stopped this atrocity, the Church was still disturbed.

It soon found that the beautiful symbolism of the Mass was being horribly distorted by other, if less bloody examples of Indian perversity. The good padres feared for the souls of their flock, if not for the prestige of the Church itself. This drove them into heroic attempts to stamp out such idolatrous practices—a campaign doomed to failure although it lasted over two hundred years. They were tilting against a graftage of Aztec lore upon Roman liturgy, but this is still rife in Mexico, particularly in the case of two plants—the ololiuqui and peyotl.

The persistence of these Aztec cults is matched only by their extraordinary hold on the Indians and by their antiquity. Their pre-Conquest history may always be shrouded in that medley of folklore and races, of which Cortes saw at Mexico City only the fantastic finale. But ololiuqui and peyotl were working their quite magical charms for centuries before that incredible Conquest, when a handful of Spaniards captured an empire.

That the Aztecs should have confused the Mass with their own magic does not surprise us quite so much as it did the dignitaries of the Church. The neighboring Mayans in Guatemala still do so in the murky gloom of that midnight Christmas service at Chichicastenango. And Elsie Clews Parsons in her extraordinarily understanding book, *Mitla—Town of the Souls,* tells us how this interweaving of Christianity and native lore permeates everything from birth to death, including the use of ololiuqui. And not so long ago some Indians in Wisconsin were tried by the United States Courts for their use of peyotl, sent to them from Texas. The chief defendant was acquitted, on the ground that the peyotl cult was "religious"—as in fact it may have been, considering that the Indians took peyotl as the faithful do communion.

In its desire to purge the Indians of the black magic of ololiuqui and peyotl, the Church left us the only writing we possess of the early use of either of these plants. For Prescott mournfully reproaches Cortes with the destruction of practically all Aztec records, a loss equally mourned today by every anthropologist and by many botanists. But the records of the Church show how potent were these plants, and how widespread their use, quite apart from their impact upon Church doctrine. We hear of both plants from a series of writings put out to instruct priests in the technique of the Confessional. One of them was called *"Camino del Cielo"* —the Road to Heaven. The object was to find out how much the "evil" had spread and where it was doing the Church the most harm. The questions illuminate not only the principal objects of them, but the life of Mexico:

"Hast thou eaten the flesh of man?"

"Hast thou eaten the peyotl?"

"Do you suck the blood of others?"

"Do you adorn with flowers places where idols are kept?"

"Do you predict future events by reading omens, explaining dreams, or tracing circles or figures in water?"

"Have you eaten the seeds of ololiuqui?"

And so on. The catechism was extensive and continued for over two centuries, for one of these instruction books was printed as late as 1760 by Fr. Bartholomé Garcia. To the somewhat bewildered Indians this ritual must have been a bit confusing. Had they not always used ololiuqui and peyotl, was not divination traditional, and could the visions caused by these two plants be other than good? One of them seems to have sensed the fact that it was better to make a

clean breast of it, at once. This sinner, back in 1634, made a confession which was reported by Bartolomeo de Alua in a book published at Mexico City: "I have believed in dreams, in magic herbs, in peyote [peyotl], and in ololiuqui, in the owl, . . ."

The admission of his traffic with the owl was as damaging as addiction to the two plants, for the Church reserved to itself the prerogatives of death. And, as Miss Parsons points out, the Aztecs considered the perching of an owl on a sick man's house a portent that, even today, no Indian at Mitla cares to ignore.

Quite apart from their use in Indian magic, these two plants have been and are still used for their effects upon the mind and nervous system of a people long inured to hardship. In the peyotl is found a potent alkaloid that interests modern science and led Havelock Ellis to use it in an experiment upon himself. The plants are botanically unrelated but their effects are similar enough to justify their linkage by Mexican clerics. And there is sound reason for the use of both ololiuqui and peyotl today.

This is scarcely surprising, for perhaps nowhere has the passionate desire to escape from reality been so developed, and so necessary, as in Mexico. One can not help noticing it, no matter from what direction one enters the country. For instance, in leaving the clean efficiency of Laredo, one meets almost too suddenly the dramatic squalor of the desert road to Monterrey. Not the industrial squalor of cities, but that immemorial stolidity of those to whom nature has been less than kind. Only with luck, and just a little foresight, can these peons hope to wring from that cactus waste enough corn and cattle to carry them through the brilliance of the rainless winter. Here are the grim realities of desert life, scarcely mitigated by rare gas stations, and perhaps only aggravated by the stream of American tourists.

For hundreds of years before we began to "do" Mexico, and over an area as large as Texas, which once belonged to them, these Indians of northern Mexico have fought for a precarious living. They may be assumed to have benefited by the influence of the Spaniards and the Church, and always they have lived close to their incomparably stark mountains—towering, treeless, to the blue immensity of the sky. But these scarcely seem to have been enough—the struggle is too bitter, the compensations too meager. For them the Gods created peyotl, or so they think, and who are we to deny the divinity of some Aztec deity?

If, on the other hand, one enters Mexico from Guatemala, what a different scene is unfolded. The anthropologists tell us that, racially, these Indians of southern Mexico are different from their Guatemalan neighbors. But the products of Oaxaca and Chiapas approach more nearly than anything in Mexico the incredibly colorful life of the Mayans of Quetzaltenango and San Marcos.

In spite of nature's apparent bounty to those Mexicans that face the Pacific, the Indians of Oaxaca are nearly as poor as those of the north. Their multi-colored tiles, basketry, glassware, silver-work, jade, woodwork, and their innumerable shrines are little more than a veneer of recent Spanish, overlaying deep strata of pure Indian. Ages before this shallow coating of modernism, their ancestors sought just as passionately as their brothers in the north for some mitigation of the disenchantments of life. This may seem strange to those tourists who think of Mitla as the very mecca of enchantment compared to the capital. But to the Indian, the ruins of Oaxaca are no compensation for the age-old problem of some flight from reality. For them it has been ololiuqui, just as peyotl is for the Indians of northern Mexico. Trade in both products exists with the result that each is now known over much of Mexico. But the origin of ololiuqui in and near Oaxaca, and peyotl near our Texas border, seems well established.

I

Throughout southern Mexico, but especially in Oaxaca, there scrambles a vine looking not unlike an anemic morning-glory, to which it is closely related. But it has a woody stem and so clambers over cactus hedges or old walls with more permanence than our common, garden morning-glory. After somewhat persistent attention by botanists, from Linnaeus in 1759 to Harvard University in 1941, the nine former

names of this plant have now simmered down to the final one, which is *Rivea corymbosa,* a Latinism here injected to quiet the apprehension of former colleagues, and for the sake of what is called "the record."

It has the heart-shaped, pointed leaves of most morning-glories, but the whitish, funnel-shaped flowers are hardly more than an inch long. These are followed by a small, fleshy fruit, in itself quite useless, but containing a single, lentil-like seed. This, and sometimes the plant itself, have been known as ololiuqui ever since the Conquest, and long before. The Aztecs may have used the name for other plants, but commonly they applied it to the seeds of *Rivea corymbosa.*

As in so many New World plants, our first record of ololiuqui came from the contemporaries of the conquest of Mexico, often priestly historians. Quite naturally these ecclesiastical chroniclers were outraged to find that the use of ololiuqui was a ritual and that it had a god of its own, worthy of veneration if one wished to benefit by miracles. One of these Spaniards, Francisco Salverio Clavigero, had this to say about the profane use of the seeds:

> Besides the usual unction with ink another extraordinary and more abominable one was practiced every time they [the Aztec priests] went to make sacrifices on the tops of the mountains, or in the dark caverns of the earth. They took a large quantity of poisonous insects . . . , burned them over some stove of the temple, and beat their ashes in a mortar together with the foot of the ocotl, tabacco, the herb Ololiuqui, and some live insects. They presented this diabolical mixture in small vessels to their gods, and afterwards rubbed their bodies with it. When thus anointed, they became fearless to every danger. . . . They called it Teopatli, or divine medicament, and imagined it to be a powerful remedy for several disorders; on which account those who were sick, and young children, went frequently to the priests to be anointed with it.

Joseph Acosta, writing in 1590, had much the same opinion, but embellished the ritual by adding: "By means of this ointment, they become witches and did see and speak with the devil. The priests being slobbered with this ointment lost all fear."

That a narcotic like ololiuqui should be venerated by the Aztecs, and have its own god which was worth invoking, is entirely in keeping with the experience of other primitive peoples. And in propitiating the god of ololiuqui the Aztec priests sometimes used far more colorful methods than the gruesome witches' broth cited above. Gathering their gorgeous native flowers, they would repeat the formula: "Come hither, thou, the yellow and ardent red one; come and expel the green pain, the brown pain, which now wishes to take away the life of the son of the Gods!"

Whether gruesome or flowery, we see in these invocations pure Aztec ritual, uncontaminated by Rome, and as yet showing little to make the Church fear that ololiuqui would ever interfere with the spread of Christianity. But the Church misjudged the veneration in which the plant was held, and should certainly be forgiven for not guessing that the Indians would soon be mistaking the Virgin for an Aztec deity. In fact, a few of the lower orders among the Spaniards may also have become contaminated by this blasphemy. For some, who must have used the seeds, were soon committing the enormity of calling them, *semilla de la virgen.*

As to the veneration in which the plant was and still is held, there can be no doubt. For the seeds have a three-fold function—as a narcotic, a medicine, and as part of the ritualistic hocus-pocus of divination. Among all but the most ignorant Indians of southern Mexico the latter virtue of ololiuqui has waned. As a medicine, in spite of the Department of Public Health at the capital, it is certainly still in use, mostly in remote hamlets such as that in *The Forgotten Village.*

But its great use, before, during, and ever since the Conquest has been as a narcotic which is supposed to confer peculiar powers. As one old chronicler puts it ". . . they consult it as an oracle in order to learn many things . . . especially those things which are beyond the power of the human mind to penetrate. . . ."

Even today we share the ignorance of those Indians, because the narcotic properties of ololiuqui are, still, something of a mystery, for unlike most others, nothing is known of the chemistry of the alkaloid and glucoside recovered from its seeds. Whatever the active principle, it seems to be most effective, for it induces ultimately a kind of hypnotic sleep or coma. At first there are hallucinations, sometimes preceded or punc-

tuated by giddiness, but as in the Indian hemp and peyotl, always leading to a kind of euphoric bliss. Most Indians who have used ololiuqui and peyotl admit that subsequent visions are pretty much the same from both plants. Because of this the final stages of intoxication from ololiuqui are best understood by comparing it with peyotl, the precise effects of which are far better known.

The Aztec dosage of ololiuqui may never be accurately determined, but the present one is almost wholly dictated by Christianity. Miss Parsons relates how potent a certain number is at Mitla where the Indians still confuse ancient lore with the Church. An Indian woman will bake thirteen tortillas, treasure thirteen beans, store thirteen jars of tepache—all in imitation of the number at the Lord's Supper. And of ololiuqui they similarly take mostly thirteen seeds soaked in water. Sometimes an alcoholic beverage is used, but it appears to add nothing to the narcotic effectiveness of the seeds, although it may mask their bitterness, which is considerable.

Unlike peyotl, ololiuqui exhibits the phenomenon of the lone drinker. Mostly used at night, it is practically always taken alone, and as one old historian puts it, always in a place "where he cannot hear even a cock's crow." In the loneliness of some adobe hut the seeker after its effects completes his brief flight from reality, lasting about three hours, and returns none the worse to the drabness of his real world. Dr. R. E. Schultes, the leading modern authority on ololiuqui, is emphatic on this lack of serious sequalae. He writes that its use "is followed by few unpleasant after effects," although, like any other drug, excessive use may be disastrous or even fatal. In modern times it rarely or never is.

In the use of ololiuqui, other than as a narcotic, medicine and divination seem not to be far apart. The seeds are in no modern pharmacopoeia, but in many native ones. Beyond some fancied, or maybe real, value as a pain-killer the ololiuqui is quite innocent of therapeutic effectiveness. Its pain-killing properties, however, have long been surmised, and Dr. Schultes suggests their subsequent investigation. But there is no question whatever about the hold that ololiuqui has on the imagination of those Indians who think that it will not only cure their ills but tell them things "which are beyond the power of the human mind to penetrate."

Upon this credulity plays the *curandero,* or medicine man. Is he, too, merely an amiable simpleton, or perhaps a misguided but authentic relic of old priesteraft, or is he just a plain rascal? It depends a lot upon the altruism of a man a little too strategically placed to remember that virtue. The fact is that he generally buys the seeds for a few centavos, charges his patients far more, and in the process invests them with a magic power upon which one can scarcely put any price. Maybe he believes it; certainly his clients do.

Apparently the curanderos of today differ little from their spiritual ancestors, the witch-doctors. Just as valid now, as when written in 1629, is Alarcon's description of how a patient fares from his curandero:

> Chronic illness, kinds which the curanderos have pronounced incurable with ordinary medicines, are attributed to witchcraft and . . . , according to their belief, cannot be cured if the one who has cast the spell does not break it. This is the usual way in which the doctors make profits and wreak much injury with the satanic superstitions surrounding ololiuqui. . . . The doctor immediately attributes the illness to witchery. . . . In order to aid the doctor, the patient relates his suspicions. The deceiving doctor immediately orders the use of ololiuqui, and the patient follows the doctor's words as though they were the words of a prophet or of an oracle. . . .

Could any modern quack want more? The simplicity of the method is unique. Narcotizing a patient with ololiuqui is far cheaper and lots easier than the elaborate hocus-pocus that passes for quack psychotherapy. Add to this the fact that curanderos offer equally valuable services in finding lost articles, guessing the outcome of illness, or battles, and other imponderables, and one has a set-up to whet the appetite of modern medical imposters.

It may be that the only honest use of ololiuqui today is by those poor, stolid Indians who take it frankly as some mitigation of their none too zestful life. As for its use by curanderos and in divination, the less said the better. Certainly no modern appraisal of such practices can match the wisdom of that penetrating priest, Jacinto de la Serna,

who wrote long ago, "It is not without concern that Christian priests see the facility with which the devil works among these people. . . ."

II

No desert stroller can help falling a little under the spell of the cacti, even if they provoke many questions. Why should they stretch fantastic arms to heaven like the sahuaro, or wallow, barrel-like, in spiny ferocity, like the melocactus? Of what use is the white, ethereal ghostliness of the night-blooming cereus, or the provocative fez of the Turk's-head? Why don't they have leaves like other plants, and most of all why their utterly unapproachable prickles? And why did one botanist so aptly call them The Fantastic Clan?

Such questions could be multiplied about thirteen hundred times, for that is the approximate number of different sorts of these weird denizens of the desert, all but a handful of which are confined to the New World. Few are of any practical use, although some, like the tuna, yield edible fruits; others, a little water for thirsty travellers; a few are used for hedges; Aztecs made needles from the spines of one of them; the nopal is still, although rarely, grown for cochineal; a very few make substitute cattle food; and scores are cultivated by fanciers, more for their interest than for their beauty. In spite of this, neither their enormous development in tropical deserts, nor the diversity of their forms, can shake most of us out of the conviction that the cacti are among the most useless of all plants—perhaps fit only for destruction, like the rank prickly pear in Australia.

But there is scarcely an Indian in Mexico, who would agree with us. No matter how many deep, cactus-clad barrancas he may be forced to detour, nor how often his tattered blue jeans become even more shreddy from their cruel spines, he still would resent their destruction. For he, far better than most of us, knows that one of the strangest, and to him the most precious, of all the cacti is the peyotl. It actually is unique, for not one of its grotesque allies, from Kansas to the Argentine, can approach the peyotl in the veneration in which it is held. For it is the only one of the huge cactus family that has so far produced an alkaloid which will mitigate the intolerable impact of reality.

Peyotl, in spite of this, is the least impressive of all the cacti, so inconspicuous that one cannot help speculating on who first noticed it and who discovered its properties. Such speculation is useless, for it was known ages before the Conquest, back in some dim period for which there are no records. But that did not prevent some inquisitive Indian from unwittingly starting a new plant cult. It still survives.

The cause of it all is *Lophophora williamsii*, which is the Latin name of the peyotl. It is a curious cactus, seven-eighths of which is buried in the ground. This submerged part is not unlike a parsnip in size and shape, with a single tap-root. Upon this apparently stealthy desire to hide itself in the ground, Francisco Hernandez put a most charitable interpretation. Writing in 1576, he says that on account of its magic properties, "this root scarcely issues forth, but conceals itself in the ground, as though unwilling to harm those who may discover it and eat it." That is one of the first records, incidentally, of the potentialities of peyotl, and it was written by a physician.

The only part of the plant to appear above ground has led to not a little confusion. For the top looks like a cluster of small, button-like mushrooms, and many, less observant than Hernandez, have frequently mistaken them for mushrooms. To further complicate the picture there actually was a narcotic mushroom in ancient Mexico, recently identified and appropriately christened in proper Latin, but its use is minor and it should no longer befog the history of peyotl. But it does, for the error is very old and at the time of the Conquest peyotl was often called the "Sacred Mushroom."

That error left a legacy that generated some later confusion. In Texas, where the peyotl is also native, the small mushroom-like buttons came to be called mescal buttons, which is singularly inappropriate, for mescal is an alcoholic beverage of Mexico and bears no buttons. In the United States, however, mescal buttons will probably always be the name for the peyotl, and mescaline is still the proper term for the chief alkaloid found in these curious dried cacti.

To call them "buttons," is, to all who never saw them growing, perfectly natural. Only a comparatively few Indians knew that this parsnip-like base of peyotl, was topped by a ribbed summit, that unlike most cacti it was spineless, and that among these ribs were button-like growths, bearing a small, rose-tinted flower surrounded by a tuft of whitish hairs. These grayish-brown button-like growths, which average a little less than two inches in diameter, look, when dry, very much like a shrivelled mushroom. It is in this form that they are sent to the capital, and it is only in the form of these "mescal buttons" that most of our own Indians ever see peyotl; here often called peyote.

The plant is confined to northern Mexico and adjacent Texas, is never very abundant, and may some day be exterminated because its collection has gone on from remote antiquity. It must once have been pretty common in the state of Coahuila, for in 1692 the priests and the Indians there seem to have joined hands in naming a mission *El Santo de Jesus Peyotes*—a variant plural of peyotl. That a mission could ever have been so named is far more incongruous than to see today a Unitarian church named for the Virgin. It was even worse, for the Church, about a hundred years earlier, had thundered against the enormity of calling peyotl "God's Flesh." No blasphemy could have been greater, although the Indians then, and even today, could scarcely pay a higher tribute to the Mass. For peyotl is venerated, and used, with all the mystic exaltation of some sensitive young priest, who for the first time officiates at the Elevation of the Host.

III

That a cactus could cause such incongruity would be unthinkable if the peyotl did not contain mescaline, which is certainly one of the most extraordinary alkaloids found in the plant world. Because of this, and long before the Conquest, Aztec priests were venerating certain plant cults, notably the peyotl, and doing it with ritualistic rites that made the Church shudder. These "heathen" priests even had a ceremony which reminded the Spaniards of the Christian communion. Diabolical as it seemed to them, "how," says Prescott, "could the Roman Catholic fail to recognize the awful ceremony of the Eucharist?"

The gathering and use of peyotl today still reminds us of some Black Mass, overlaid by Indian lore, and fundamentally dictated by what mescaline will do to the brain and nervous system. And because it is gathered and used by several different tribes in northern Mexico, the ceremonies differ somewhat. Also, to use here the different vernacular names for the plant would be to confuse something that is really quite simple.

One tribe begins the collection of peyotl in October, and those who are to gather it, before starting on their ten day journey, are feted by the burning of copal incense. Thus consecrated, they proceed to the gathering grounds, upon which a cross is erected. When the plants are first approached, the more devout will cross themselves, in the name of the Father, the Son, and Holy Ghost —the latter abstraction being, to the Indian, the peyotl. Flights of arrows, discharged right and left of the plants, are to warn off evil spirits. During the expedition, which in another tribe takes forty-three days, no salt or paprika is eaten and all refrain from copulation. Many paint their faces and decorate their hair and hats with feathers to indicate devotion to their special gods.

Upon their return, the villagers welcome them with music and dancing. Their precious hoard is reverently placed at the foot of the cross and sprinkled with a mild alcoholic beverage—often tiswin or pulque. A sheep or ox is sometimes sacrificed to peyotl the next day, and one gets some idea of their relative value by the gatherers once charging a sheep for a single plant, root and all, with its "buttons."

Then begins a ceremony, perfectly justifying an old chronicler in calling peyotl *raiz diabolica*, the devil's root. Today, in deference to Christianity, the ceremony starts after sundown on Saturday, and ends about noon on Sunday. Those who are to partake sit in a circle in a sacred tipi, or on the ground, which has been well brushed for the purpose. There is always a flickering fire. After an opening prayer, each is handed four dried "buttons," or in some tribes slices of the root-like base. After chewing, and spitting out the first bitterish extract, the re-

maining pulp is rolled into a pellet and swallowed at once. In three hours the hallucinations begin. Of these Lewin says, "they are of such a special nature and so superior to reality, so unimaginable, that the victim believes himself transported to a new world of sensibility and intelligence."

Certainly no stolid Indian has ever been really articulate as to just what peyotl does for him and fortunately it does not matter. We can the better postpone, therefore, an account of its peculiar properties to the more lucid explanation of modern doctors and Havelock Ellis. But from remote antiquity these Indians, as well as many in the southwestern United States, have their regular peyotl services, which, today, often coincide with saint's days.

It seems inescapable that they never dissociate its narcotic properties from divinity. No one knows in how many remote Mexican hamlets this circle of people, who seek some flight from reality, think of it truly as the gift of God. In some tipis, murky in the flickering firelight, there is an altar upon which peyotl is consecrated as the Host, no doubt by some ancient Aztec rite, and subsequently taken as communion. In other communities a beverage is made from it and used as holy water to christen a child. Novices, taking their first peyotl, are fanned by an eagle's wing while this holy water is used to make signs on their foreheads.

In still other tribes, the peyotl rite comes nearer to an orgy than a service, perhaps induced by the addition of pulque. Here the root is ground up, mixed with pulque, and imbibed pretty frequently. To the music of a "choirmaster" and his instrumentalist they dance in a circle, singing an unearthly, quite unmusical dirge, without stopping or leaving the circle, often throughout the night. The padre Jose Ortega, who saw such a "service" nearly three hundred years ago, describes the end thus: "When the dance was ended all stood who could hold themselves on their feet; for the majority, from the peyotl and the wine which they drank were unable to utilize their legs to stand upright."

Peyotl, however, is pretty generally free from any stigma of debauchery, is rarely associated with alcoholic intoxication, and is not an aphrodisiac. These facts no doubt dictated the acquittal of an extraordinary defendant in a trial in Wisconsin—The United States vs. Nah-qua-tah-tuck, an Indian living on a reservation. This is far from where peyotl grows, but such is the hold of the plant on the Indians, that they regularly imported it from near Laredo, Texas, where it grows within sight of the International Bridge. Such shipments are illegal, but the Indians got their supplies by the not very subterranean aid of the parcel post. Hence Uncle Sam's interest in the case, to which he sent a battery of legal and pharmacological experts.

The Indian testified that far from being wicked, peyotl was divine, its use religious and before taking it the Indians "invoked God, begging Him to make all of them good and to keep them from evil." That invocation followed an attempt by all the Indians to keep out the evil spirits, by the simple method of drawing a line about the house. Several witnesses were called. They, too, testified: "that he ate the peyotl so that his soul might go up to God" and "that peyotl helped them to lead better lives and to forsake alcoholic drinks."

At the same trial Thomas Prescott of Wittenberg, Wisconsin, an American, testified that for seven years he had been a "priest" of a joint society known to him as the Union Church Society, and to its Indian members as the Peyote Society. At weekly services the parishioners either ate peyotl or took it as tea, and apparently with much benefit, for, "they gave up drink, established themselves in regular homes, and lived sober and industrious lives." As for himself, the Rev. Prescott testified, "it stopped me from drinking, and now since I used this peyote, I have been sober, and today I am sober yet." This was too much for the government experts, and Uncle Sam decided to go back to Washington where the records of this fantastic trial still moulder.

In spite of wandering as far afield as Wisconsin, the peyotl cult was originally endemic only in Mexico and the region adjoining it in our Southwest. Today the Apaches, Omahas, Kiowas, Comanches, and many other tribes all use it, in spite of a United States law against it. All of these know it only in the form of "mescal buttons" which

they import from Mexico and the Rio Grande region of Texas. They have many modifications of the peyotl ritual, practically all religious, one of them closing with the song, "This is the road that Jesus showed us to walk in."

All their testimony, and most of the records from the Conquest insist that it is not habit-forming, nor does it usually do any physical damage to those who use it. Like the Indian hemp and ololiuqui, there is thus no real addiction problem, but as in any other narcotic, prolonged over-dosage can bring disaster. But centuries of use, although admittedly confined to only a few million people, has left the peyotl with a reputation unique among more dangerous narcotics. Its effects, so far from being degrading, seem quite the reverse. You could make no Indian understand that peyotl was ever a moral problem, in the reformer's sense of that word. His answer, if he were generally articulate, would very likely match those who are. And perhaps, who knows, he may be grateful to a particularly understanding and intelligent Englishman who tried peyotl on himself and left a very lucid record of his experience in the *Contemporary Review* for January, 1898.

IV

One Good Friday afternoon, in 1897, Havelock Ellis was sitting in his study in the Temple, reflecting upon a "new artificial paradise" which had come to his attention from Dr. S. Weir Mitchell, a distinguished physician. Ellis not only reflected upon it but had supplied himself with a collection of "mescal buttons"—the only name he knew for peyotl, as his supply had come from this country.

He determined to see just what mescaline did to the brain and nervous system, whether he could repeat the "brilliant visions" about which Dr. Mitchell had written, and lastly, whether he could remain lucid enough to write down his impressions. In the gathering gloom of a London afternoon he began his experiment, alone, with a fire in the grate, for he sensed that he "could see these visions best only in a room with flickering firelight, as with the Indians."

Having made a decoction of three buttons, "the full physiological dose," he drank it at intervals for two hours until there was none left. Perhaps that took more courage than it would today, for maybe he did not know that the Indians considered four buttons as a dose. In any case, he felt at the last drink of peyotl only a little faint and unsteady, which was not very alarming if it grew no worse. Generally he avoids mentioning, in the *Contemporary Review* article, any purely physical manifestations of its effects, for he had already written to the *Lancet* on this phase of peyotl intoxication. At first, beyond the faintness, nothing at all happened, but then, very gradually, pale violet shadows floated over the page he was reading. These were intensified by closing his eyes, sitting there in the darkened room with only the flickering firelight.

Later in the evening, the visions "became distinct but still indescribable—mostly a vast field of golden jewels, studded with red and green stones, ever changing. This moment was, perhaps, the most delightful of the experience, for at the same time the air around me seemed to be flushed with vague perfumes, producing with the visions a delicious effect."

At about this stage he felt "a tremor of the hands, which, later on made it almost impossible to guide a pen as I made notes on the experiment; it was, however, with an effort, always possible to write with a pencil." He, like numerous others, felt what Lewin has so aptly described as "a kind of removal from earthly cares and the appearance of a purely internal life which excites astonishment." He saw indescribably beautiful colors and forms, but the latter "never resembled familiar objects."

Such effects, as seen through the eyes of this intelligent recorder, must appear to the stolid Indian as even more fabulous. Changes of sense, hearing, color, perceptions, taste—how could they fail to denote divinity to those Mexican Indians, who, poles apart from Havelock Ellis, were united for that one afternoon, in the ecstasy of pure enchantment.

Ellis did not exaggerate when he called peyotl an artificial paradise. He became so enthusiastic that he subsequently tried peyotl on an artist friend, but nearly "killed

him," by giving four buttons which, besides the visions, induced heavy breathing and numbness. Later he tried it on two poets, using his own dosage and taking careful notes on the effects. They matched or exceeded his own.

He sums it all up by saying it may be dangerous to weak people but gives wonderful effects to robust ones. "It may at least be claimed that for a healthy person to be once or twice admitted to the rites of mescal is not only an unforgettable delight, but an educational influence of no mean value."

More than thirty years later, Dr. Eric Guttman of the Maudsley Hospital, London, became convinced that mescaline was a plant alkaloid decidedly worth more investigation. He used mescaline, the pure alkaloid, rather than the "buttons" so as to control the dosage more accurately. In recognizing mescaline as the pertinent alkaloid of the peyotl, he rejected the suggestions of Dr. Lewin, of Berlin, who insisted that he had isolated another and more important principle of peyotl, and that it came not from *Lophophora williamsii*, but from another species, named for him *Lophophora lewinii*, a plant no longer considered distinct from peyotl. Having cleared away this pharmacological and botanical wreckage, Dr. Guttman was ready to study just what mescaline did to the mind.

He chose sixty people "of sound mind" who volunteered for the experiment. It is impossible here to retail the experiences of all those who contributed so much to our knowledge of what peyotl will do. But a few clamor for inclusion. One of them reported, after the initial intoxication had proceeded for a while:

> At first they were no more than indefinite, white clouds moving on a dull black background. Soon they became clearly defined, and resolved into an interlacing pattern of white lines. The background became a deeper and richer black, the lines themselves were exquisitely sharp, fine and delicate. I saw a human eye, some faces traced by the lines in their earlier stages, but for the most part the rich black background was covered by meaningless arabesques, never still, crossing and interweaving in an endless flow. Every line was duplicated, its outline repeated again and again, growing at each repetition fainter, until, infinitely multiplied, it receded into eternity. New color entered upon the scene. The white lines turned to yellow and orange, thickening until broad patches of brilliant color glowed against the black, always beautifully defined. Other colors appeared, a superb emerald green, iridescent as a humming bird's wings, red like the sound of a trumpet, a flaming orange, a vivid purple.

Another volunteer saw a heavenly body "which was glowing like an iridescent plum pudding suspended in the sky exactly a hundred miles above the earth." Lightning and snow-clad mountains appeared which seemed to demand that the former should strike. Then he saw his "plum pudding" had changed into an Aztec figure to whom "innumerable pairs of white uplifted arms" were stretched in supplication. "I looked again at him to see how he was proposing to respond to these supplications, and was surprised to see that he had changed into Dr. N., who was at the same time, God. He seemed about a mile high, and I saw him in profile, dressed in a long white robe or toga, like Caesar, participating in a triumph —a wonderfully majestic figure. In his extended right hand he held the lightning in a flickering sheath of electricity."

If a London medical student could mistake a colleague for God, under a controlled dosage of mescaline, perhaps the padres were right in thinking that Aztecs were doing precisely the same thing with peyotl four thousand miles away, and much more than four hundred years ago.

It takes little flight of the imagination to understand how ololiuqui and peyotl came to be what they are. For both of them have provided at least temporary release from the corroding curse of boredom, apprehension, and disenchantment. Perhaps the fortunate among us, who of course never suffer these evils, not only can understand, but may forgive, those patient Indians for their plea, "Come and Expel the Green Pain."

A BOTANIST'S DOMINICA DIARY

I. IN AND ABOUT ROSEAU

By W. H. HODGE

THE geographies included Dominica in the wet tropics; the travel guides warned of a rainy summer season; and when the deck steward casually remarked, after a fair passage, that there would be rain all right in Roseau, we actually were glad to receive the first welcoming Sunday deluge at anchorage. It was all a sort of promise, for an island that thrusts emerald-green peaks into blue-black clouds must catch lots of rain, and lots of rain means lots of plants—which are to a botanist what pie is to a small boy!

Botanists will easily see with what joy and excitement we looked forward to meeting the new and exotic flora of a real honest-to-goodness tropical isle. We sighted our island on a Sunday, the same day of the week on which Columbus himself discovered this paradise (Dominica was the first landfall, November 3, 1493, of his second voyage) and because of that fact called it Domingo, the Spanish for Sunday—and hence Dominica.

Roseau, the chief town of the island, which itself is little more than an overgrown vil-

NEW STREET, TYPICAL OF THE CLEANLINESS OF ROSEAU

THE LITTLE ISLAND OF DOMINICA IS ONE OF THE MOST HEALTHFUL OF ALL THE WEST INDIES.

DOMINICA: A PICTORIAL MAP

lage, is tightly jammed upon the only available level ground bordering the rugged Dominica coastline—a small delta hewn from the very mountains and tumbled down to the sea margin by the action of Roseau's lusty little river. The arrival of a steamer is the alarm clock that awakens the town. The white docks swarm with Negro folk eager to watch or to earn a coin. From this assemblage of humanity it was no task to find a porter—with a head and neck of steel! A steamer trunk filled with liquids, alcohol,

formalin, and other miscellaneous preservatives, is no feather for anyone's cap, and yet with this upon his head our black Atlas added a tightly packed valise plus two large cartons of plant-pressing materials; beneath each arm was placed a smaller package, and in each hand a suitcase just for balance! Thus assembled as a walking express he made his quarter-mile trek to our lodging place.

The departure of the steamer soon enables the turbulence of the town to settle out, and business, again quiet, focuses on the next arrival. The banana piles by the jetties have been depleted; bare-foot country peasants wend their way home to their palm-thatched mountain homes, or *ajoupas;* the fisherfolk while away their time offshore, where in the blue deeps flying-fish, red snappers, dolphins, kingfish, tunny, or jacks may be had for the fishing; and on the checkerboard of clean streets little groups of natives are quietly gossiping in the heat of the day, while the serenity of all is reflected in the chickens which wander from gutter to gutter picking up those few scraps that may have escaped the eyes of the early-morning sweepers. For inhabitants of a tropical town, the people have been well schooled in the necessity of cleanliness, as the results show, for Dominica is one of the most healthful of all the West Indian isles.

Tiny Roseau has but one real attraction—her botanic gardens. In the beauty of this well-kept English park, which complements rather than vies with the natural vegetation of the surrounding mountains, one can find growing nearly all the outstanding representatives of the world's tropical flora. Indeed, the Roseau Gardens are famed as among the best in the West Indies; they possess particularly one of the finest palm collections in the Western Hemisphere. Within its gates are held many of the sporting activities of the island, for enclosed by a row of spreading saman trees is a well-kept greensward, site for weekly invitation cricket matches; here on Sundays the populace relaxes, enjoying the lush beauty as does a throng of New Yorkers set loose in Central Park. The larger part of the botanical establishment is at present set off for economic plant research designed to improve the productiveness of the island's agriculture through the introduction of new crops or of disease-resistant strains of the old.

THE TOWN OF ROSEAU

THIS SMALL CAPITAL TOWN IS LAID OUT ON A DELTA, WHICH IS THE ISLAND'S ONLY FLAT LAND.

The gardens early in the morning are a mecca for all life. The cassias, poincianas, and samans attract swarms of hummingbirds, blue-crested, green, and red-throated, as well as king bees, in size hardly distinguishable from the avian visitors. It is not unusual to see a mixed company of almost a hundred of these bees pirouetting among the branches of a single large flowering tree. The buzzing of wings in the air has an accompaniment of rustling in the ground litter, the dead leaves which, characteristic of evergreen trees, are ever-present on a tropic forest floor. Running this way and that always just beyond reach are beautiful blue-backed skinks, or ground lizards, interrogating the presence of the two-legged intruders with lightning-like protrusions of their tongues. In a region of bountiful insect and vegetable food it is no wonder lizards abound, and their ceaseless crashing around in the underbrush creates a racket far out of proportion to the creatures' size.

From the rear of the gardens rise the steep

BANANA LIGHTERS NEAR THE ROSEAU ANCHORAGE

SINCE DOMINICA HAS NO GOOD HARBOR, SHIPS HAVE TO ANCHOR OFFSHORE. IN THE RIGHT BACKGROUND IS THE SOUTHWESTERN TIP OF THE ISLAND—SCOTS HEAD—ONCE HEAVILY FORTIFIED.

slopes of Morne Bruce, from whose summit, reached by a zigzag path, can be seen all of Roseau from the tiny wharves to the spread of the gardens several hundred feet below. What past sights the Morne must have seen, for like her giant sister peaks towering in the background she overlooks a part of the Caribbean that has always been glamorous, having borne successively on her heaving swells Carib canoes, Spanish galleons, French and British frigates. Today, even in wartime, the tranquility of this, Roseau's guardian peak, is reflected on the western crest by the shrine and cross overlooking the town, on the eastern crest by an old mango tree which hangs over one of Dominica's most accessible and breath-taking panoramas—a view of the mountain-bordered Roseau River Valley clambering far below, yet ever upward to the base of the Lake Mountain and the rising point of the sun.

Few of Dominica's highways extend for more than a dozen miles, although the Portsmouth-Marigot "turnpike" has the unbelievable length of twenty-two miles! What Dominica's roads lack in length and width

they make up in startling views and sudden grades and curves that try to break the vehicle in two. The wonder is not the scarcity of roads but that the government authorities were able to construct any. Take a range of mountains rugged and precipitous; dip them into the Caribbean so that 5,000 feet of their summits rise sheer from the sea; cloak them with verdure that only the rainy tropics can produce; then try to cut roads through—roads that will stick to the sides of the deep ravines and valleys and that will not be obliterated at the first daily deluge. Here in a nutshell are the difficulties of Dominica road-building!

Walsh was a good driver and the scenery on the way to Bellevue was fascinating; first came the shore road with its border of cocoanut palms making alluring the seaside hovels, picturesque with their gaping fauna of natives, chickens, and mongrel dogs and sheltered by the ever-present breadfruit or mango tree. Like leaf-cutting ants in one continuous line, the road-pursuing humanity presented an ever-changing aspect; these by the sea are fisherfolk—one would readily know it; boats, half rowboat, half canoe, are drawn up everywhere on the beach or are stored beneath palm-thatched shelters; in the shade of this shanty is a weaver of fish-pots; just beyond, around that inviting curve, the knell is being sounded for the sale of a pile of still-brilliant blue parrotfish, the purchasers called by the low moan of the sea, emitted by a conch horn. But the road cannot continue forever to the south for Pointe

UNLOADING FLOUR NEAR THE ROSEAU ANCHORAGE

SUCH COMMODITIES ARE IMPORTED FROM CANADA BUT, BECAUSE OF THE WAR, IMPORTS HAVE PRACTICALLY STOPPED. THE HOGSHEADS ON THE RIGHT CONTAIN MANGOES PREPARED FOR EXPORT.

Michel and Scots Head are just beyond, and then nothing but sea. Sure enough, Walsh turns east abruptly at Loubière—the scene of a desperate attack (1805) on the island by Napoleon's General La Grange—and the road pitches steeply upward. The scenery rapidly changes; there are fewer tiny houses, but here and there a larger estate house appears among the foliage. Cocoa trees now border the roadway, banana plots are everywhere, and still there are the wayfarers descending now in waning numbers from no

A LANE OF WINE PALMS IN THE BOTANIC GARDEN

THE ROSEAU GARDENS, AS WELL KEPT AS AN ENGLISH PARK, HAVE ONE OF THE FINEST PALM COLLECTIONS IN THIS HEMISPHERE. THE ASSOCIATED AGRICULTURAL STATION IS AN AID TO LOCAL PLANTERS.

one knows where, down, down, down into the town carrying a cross-section of the island's produce. Take a look at the various loaded heads. Most common of Dominica's coiffeurs is a bunch of green bananas probably bound for the distant Canadian markets. Clarice, our maid, tells us that a woman will probably get a shilling for growing the bunch, carrying it a dozen miles, and depositing it at the island's cooperative banana exchange.

Bananas are not the only story though, for mangoes, like oxhearts, dasheens, and breadfruits, are piled high on the heads of these human truckhorses. Now a walking haystack approaches, and only when near do we find the beast of burden to be an old woman with maidenly carriage.

For six long miles we had been thrusting the engine of the car into the sky; every one of the many turns was a possible jumping-off spot to a green, stream-gouged, verdant chasm, hundreds of feet below. What civilization had existed had long since disappeared, and the plantain-covered slopes, unbelievably steep for cultivation, were being claimed by a vegetation born of nature. Tree ferns, as only Dominica can produce them, predominated, arching over the roadway and filtering motes of sunlight through a filigree of fronds. There are five kinds of tree ferns on this little island plus about 200 other fern species, which vary from thirty-foot arborescent giants to tiny filmy epiphytes scarcely a quarter of an inch high. Real variety when one considers that so-called ferny New England can boast of a mere sixty odd species!

Near Bellevue we found heaven in a castle in the air, a modest one-story dwelling tied to the ground by a ten-foot poinsettia hedge. The simplicity of the walls of the three rooms well set off the landscape murals that were the mountain vistas framed by the screenless windows (no insects). There were no electric lights, fans, or refrigerators, no hot or cold running water, no tennis courts or swimming pools—none of those things that make life so like a yardstick.

The sole boundaries of this kingdom were mountains; behind our cloud-swept castle towered Morne Anglais, supported it seemed by two lofty coconut palms, sentinels at our back door. Beyond our front steps two other peaks rose, one to the north and one to the south, the shoulders of the latter, Morne Plat Pays, slipping into the Caribbean only, it seemed, to rise again thirty miles due south in the hazy mirage that was catastrophic Mount Pelée on distant Martinique. Close at hand, for our work, was the untrammeled rain forest; a bare hundred feet from the back door and in another direction were the

ALL LOADS ARE "HEADED"

MAN ON THE LEFT IS THE ROSEAU-ROSALIE POSTMAN WHOSE ROUTE CARRIES HIM FIFTEEN HARD MILES ACROSS THE ISLAND'S RUGGED BACKBONE.

cultivated areas which represented our vegetable supply.

Every kingdom must have its subjects, and Lisdara was no exception. Most important was Clarice who managed our day for us; it was she who woke us with the birds; she was the cook as well as our maid and lady-in-waiting, and besides all this she fulfilled the position of technical assistant, interpreter, and publicity girl. Could we have asked for more, especially at five shillings a week? "Master," she would say, "your plants are about cooked," and the Master, whose plants could only be dried by means of artificial

THE BOTANIC GARDENS
MORNE BRUCE AND SHRINE IN THE BACKGROUND.

heat, would run to the improvised rain-barrel heater in the kitchen to replace the "cooked" plants, in press, with some fresh specimens.

On an island not noted for the excellence of its communication system, it was little short of miraculous to find that knowledge of our coming had long preceded us. Our equipment had scarcely been unloaded when a babble of native voices, conversing in the universal creole patois that bespeaks a former French affiliation, descended upon us, and Clarice burst in with, "Men are without to sell you things!" Dominica venders; how they ever knew we were scientists still baffles me, but here they were on the front steps. There were old men and young men, boys and even children, each with his little contribution for sale—hopping *crapaux* (frogs), a *tête chien* (Dominica boa), geckos and centipedes, blue crabs and black crabs—everything except plants! It did not take us long to venture into the green of the forest beyond the house and onto a trail which dipped either down or up in one of the only two possible directions, through forests that continually dripped, for at this altitude we were really in cloudland. An umbrella was a standard encumbrance in the rainy season; not for ourselves but for the camera, since one could never be sure that, with camera all set up on tripod, the elements would not open up and drench the equipment. In Dominica there is seldom a steady downpour but rather a series of short cloudbursts from the puffy cumulus clouds that are pushed along by the moist east-west trade-winds. Their shadow paths are marked by sheets of water which, starting upon the distant forested slopes with a low moan, rapidly increase to a roar in the nearby trees only to prance upon the corrugations of the galvanized roof with a flailing power that drowns out sounds beneath. It is fun to predict the weather in the mountains. A good estimate is that on fair days it rains "cats and dogs" about once an hour, whereas on rainy days a deluge can be expected about once every fifteen minutes. No wonder rainfall can be measured in feet, for the annual precipitation at 2,000 feet altitude is well over 200 inches, while at 4,000 feet rainfall is enormous, probably reaching 400 inches a year. Such incessant rain certainly is a boom to plant life. Our pet cotlette tree in the front of the house proved this well, for all over its limbs, in Dominica luxuriance, sat scores of guest plants—clambering ferns, brilliant bromelias, and tiny orchids. Several hours of collecting from just this one tree gave hint of the riotous production of the tropics.

To make good botanical specimens tropic plant collections require artificial heat, lack of which in a supersaturated atmosphere means attack by mold and mildew, chief enemies of the botanic collector. We had filched one of the galvanized rain barrels used to collect our water supply. In the bottom was placed one of those little charcoal stoves, common on the island, and on

A LOCAL MOUNTAIN FROG
FROGS' LEGS, CALLED "MOUNTAIN CHICKEN," ARE THE TENDEREST DELICACY ON THIS ISLAND.

which in some unbelievable fashion Clarice would prepare everything that went into a full-course dinner. Across the top of the barrel were placed the plant presses; thus arranged, the heat rising through the corrugated channels of the press would in a day thoroughly dry all succulent specimens.

Work was interrupted only by meals, pleasantly varied so as to be exemplary of West Indian offerings. Our menu included "mountain chicken," the tender legs of a mountain frog called *crapaud*, in patios. These were caught by means of flares at night, and twelve cents' worth supplied a delicious meal. Another meat was smoked agouti, greatest delicacy the island can offer, with a wild flavor nearest to ham and prepared from the island's piglike native mammal (*Dasyprocta*); crab-backs, crab-meat served in the shell of the omnipresent *cirique* land crab; *tritri*, slender minnowlike fish which in season ascend the rivers in such numbers as even to fill the water supply and startle the stranger by swimming around in his bath; souse, the Dominica Sunday breakfast dish made of long-boiled pickled pig's feet served with cucumbers and condiments. As side dishes one could expect the ubiquitous banana, prepared often as a vegetable and served in a multitude of delightful forms running from baked plantain to a fried form which reminded us of candied yams. Fruits were from Heaven, just out of the window; the juicy sweetness of mangoes or fresh pineapples, the pulpy whiteness of a sugar-apple, or best of all the indescribable flavor of a garnet mangosteen; we tried them all.

TROPICAL PLANT COLLECTIONS REQUIRE ARTIFICIAL HEAT

AN OLD OIL DRUM, CHARCOAL FIRE AND NATIVE LEAN-TO ARE AIDS TO THE DOMINICAN BOTANIST.

In 1791 Thomas Atwood, writing a history of Dominica, noted that two-thirds of the island was covered by forest. This forest area still remains intact for, although the companion Antillean islands, because of their comparative lowness and accessibility, have lost much of their original stands, Dominica alone has retained them. Her loftiness has been at once her savior and the millstone around her neck, for, although her beauty has never aged, she has had to sacrifice riches for it since economically speaking Dominica is poor. Her soil is rich, but the difficulty is to cultivate soil which is situated on what are for all intents and purposes

ninety degree slopes and which when cleared of forest become sterile and eroded away by landslides caused by incessant rain.

It is amazing, under such adverse conditions, that fruit culture should prosper; and yet it does, with the aid of empire tariffs. Every other Saturday when one of the shimmering white mail ships (now in wartime camouflage) announces itself with a clatter of anchor chain, there are at Roseau upward of ten to twenty thousand stems of bright-green bananas lying in their packing of coconut rubble awaiting shipment to Canada's northern markets. This fortnightly shipment represents chiefly the cumulative additions of small native gardens. A Dominica peasant may be "as poor as Job's turkey" but he usually owns land, for land is available to almost anyone who will keep it cleared and cultivated; furthermore, he never need worry about taxes, for this is one of the places in the world which knows nothing of land taxes! For the lover of the outdoors this is the place to retire, on an island where forested crown lands are still available at $2.50 an acre. Since the exposed coastal soils are the poorest and least productive, most peasant holdings are situated inland far from the seaside villages, and so we may add that Dominica's agricultural peasantry is a race of commuters, daily walking lengthy distances over rugged terrain from their tiny homes in the villages to their gardens hanging onto the precipitous sides of volcanic peaks. No wonder the toiler of the soil remains poor! The best part of his day is a tedious hike to and from his tiny mountain plot, and as one native so aptly put it, he has to rest the intervening period in order to gain enough strength to walk home again! Perhaps it is this strength that the average wayfarer has in mind when he tries to get some quick energy by thieving some of his neighbor's produce from the garden by the road. To guard against just such plundering is the purpose of many of the inaccessible little cultivated plots that the traveler sees far above the trails; and knowing this, one can understand the little signs in the Roseau market place that read "Licensed to sell protected produce."

But although bananas help to bring what little wherewithal this tiny isle possesses, Dominica long ago associated itself with limes and lime production. So well at first did the cultivation of this fruit progress that at the beginning of the first World War the center of the world's lime industry was focused on the coastal plantations of this Windward isle. Green limes, pickled limes, raw juice, citrate of lime, essential oil of limes, and Otto of limes—all found their way to the United States and to parts of the British Empire. It is said even that the English term "limy" originated here. It is true that Dominica juice was issued for many years to the British Navy on account of its antiscorbutic properties, and only the transfer of affection for economy's sake from empire-grown limes to Sicilian lemons succeeded in again causing the strangulation of a prospering industry. New citrus diseases have not hindered its decline, nor have the ravages of periodic hurricanes, which, born in the Atlantic east of the island, increase sufficiently in fury to roll up heavy devastation in the orchards.

(To be concluded)

WOOD COMES OF AGE

By F. J. CHAMPION

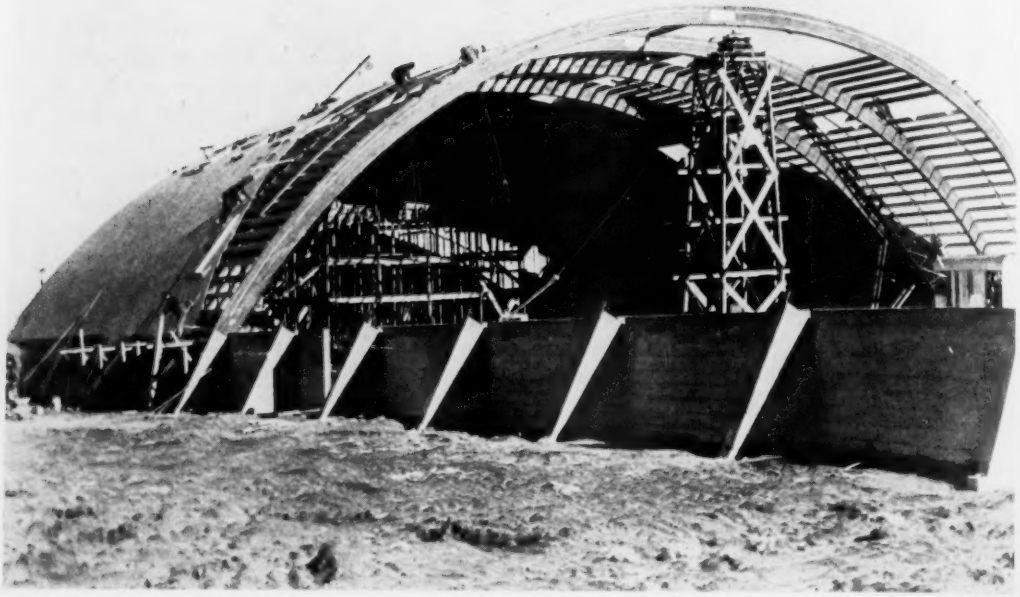
In the inevitable postwar struggle of raw materials for commodity markets, wood will meet intensified competition from metals, plastics, ceramics, glass, and other products. But wood, like competing materials, will be available in improved forms—for the centuries of empiricism in the use of wood are drawing to a close and at last wood is technologically coming of age. War has tremendously accelerated the process. Even now a number of new products of the forest are already serving the war effort, and the ironing out of technical shortcomings and production difficulties of other forest products is being so stimulated that developmental work ordinarily requiring years is being accomplished in months.

Some of the new wood derivatives and modified wood products are so altered as not to be recognized as wood; others look like wood but magnify wood's major virtues and add to its versatility. Notable among the improvements in properties is the reduction of swelling and shrinking characteristics of normal wood that have often limited its serviceability.

Some of the newer wood products, already established in the service of war production and now past the period of development and trial, are in use in the construction field. Moisture-resistant plywood is notable in this field. The development of ordinary plywood, a product that dates back hundreds of years, made wood available in large sheets having properties more nearly uniform in all directions than normal wood, but it was only when weather-resistant glues were developed that this material assumed major importance

WOODEN FOOT BRIDGE AT MADISON, WISCONSIN

THE FIRST LAMINATED ARCH BRIDGE OVER U. S WATER IS SUPPORTED ON TWO GLUED LAMINATED ARCHES.



BUTTRESSED GLUED LAMINATED WOOD ARCHES FOR FIELD HOUSE
GUSTAVUS ADOLPHUS COLLEGE. THESE PROVIDE WIDE SPANS WITH UNOBSTRUCTED FLOOR AND OVERHEAD SPACE.

as a material for outdoor uses, especially for housing and for industrial and farm structures.

A considerable portion of the effort toward mass production of housing—conventional, prefabricated, and demountable—achieved significant headway only with the development of water-resistant phenolic-resin glues for structural plywood.

One of the earliest successful efforts to design a practical factory-fabricated system of building units for house construction based on plywood took place at the Forest Products Laboratory of the Forest Service, U. S. Department of Agriculture. Using the monocoque or stressed-skin principle common in aircraft design, plywood-covered building units planned to a 4-foot modulus, complete with insulation, moisture barriers, wiring, etc., were designed, and several model houses were erected on the Forest Products Laboratory grounds at Madison, Wisconsin, and are still giving satisfactory service after eight years of testing, observation, and occupancy.

The plywood covering of all the wall, floor, roof, window, and door units was glued, rather than nailed, to a light structural framework. One model house, when it was demolished to make way for another structure, showed ample resistance to wracking tests not likely to be encountered in anything short of a hurricane.

The stressed skin principle implies that, unlike conventional frame walls which consist of a heavy framework on which coverings are suspended as dead loads, the stressed skin panels divide the weight of the structure between the frame members and the glued-on plywood, hence the light framework used and relatively thin exterior walls (3 inches), and the ease and speed with which the units can be erected.

The Forest Products Laboratory prefabri-

fication system, with modifications suggested by the experience of various fabricators and erectors, has been widely adopted and its influence is seen in the thousands of prefabricated plywood units that now shelter workers in war-crowded communities.

Heavy timber construction has made two important advances in recent years—modern connectors for improving timber joint strength and glued laminated arches—both items coming into considerable use just in time to help build many war structures, from shipways to camp recreation centers.

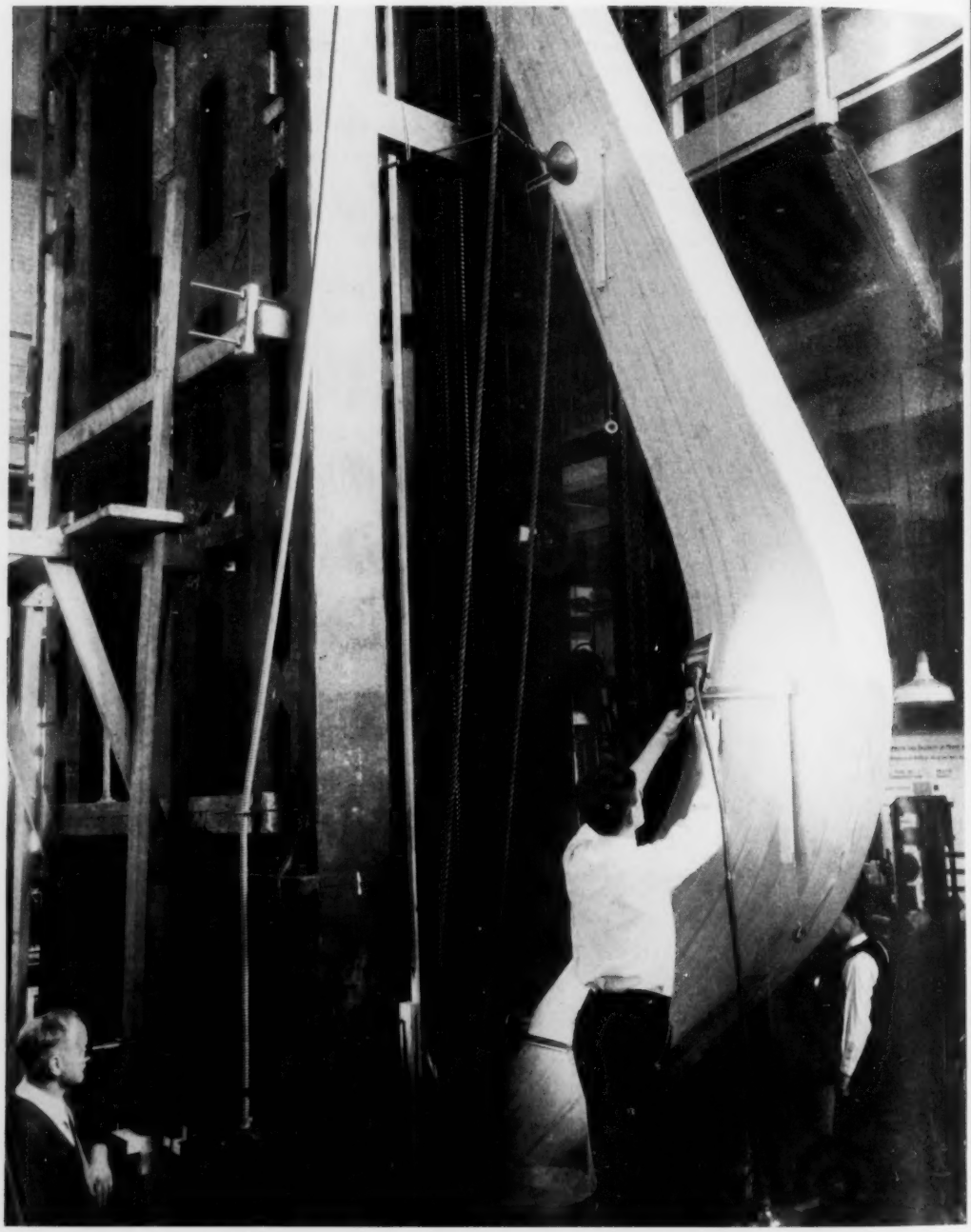
The weakest links in any conventional timber construction obviously are the joints, where loads are passed from one wooden member to another. Because of the relatively small cross sections of the steel bolts used, these transmitted loads are applied as shearing forces on areas of an inch (or less) of wood. Modern connectors are iron, steel, or even wooden rings, plates, or dowels inserted between timbers and surrounding the bolts to bring greater areas of wood into bearing and consequently to greatly increase the over-all strength of an entire timber structure.

To illustrate the effect of the metal connectors, wood radio towers, formerly limited to a height of about 100 feet because of the limitations of joint strength, can now be erected to a height of 300 to 400 feet. The use of connectors has been estimated to have saved 400,000 tons of steel in 1942, beside assuring joints 4 to 5 times as strong as anything possible with bolts alone. In many wood shipways, factories, warehouses, railroad bridges, and similar structures, connector-built joints are the literal sinews of war.

Other limitations of wood in the structural field have been surmounted by the engineering of large glued wood arches. Wood structural members are no longer limited by the practical size limits of timber coming from the mills, nor limited in shape by the

VERSATILITY OF THE GLUED LAMINATED WOOD ARCH

ILLUSTRATED BY THE DESIGN OF THE ROOF OF THIS NIGHT CLUB WITH ITS NEARLY SPHERICAL CONTOURS.

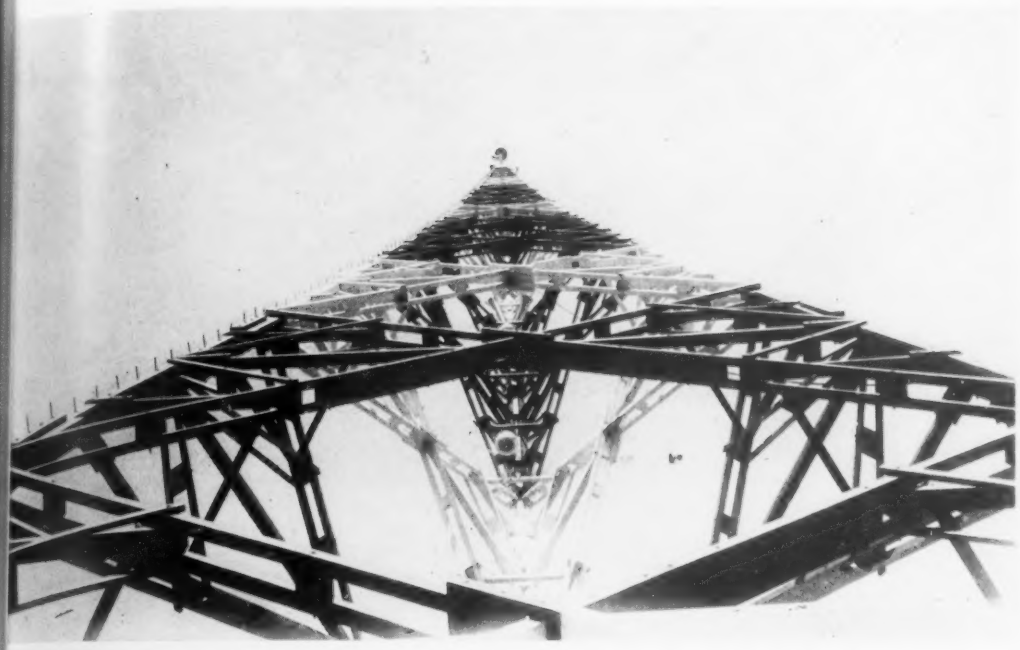


A FULL SIZED GLUED LAMINATED ARCH

BEING TESTED IN THE MILLION-POUND TESTING MACHINE AT THE UNITED STATES FOREST PRODUCTS LABORATORY

fact that tree boles bear little resemblance to trusses or arches.

The use of glued arches in this country received real impetus when the Forest Products Laboratory undertook basic investigations and tests and published data that made it possible for American construction men to design wood arches on sound engineering principles. Arches in use today vary from flat ellipsoid types with a clear span of over



TIMBER-JOINTED, 326-FOOT WOOD TOWER OF WRVA, RICHMOND, VIRGINIA

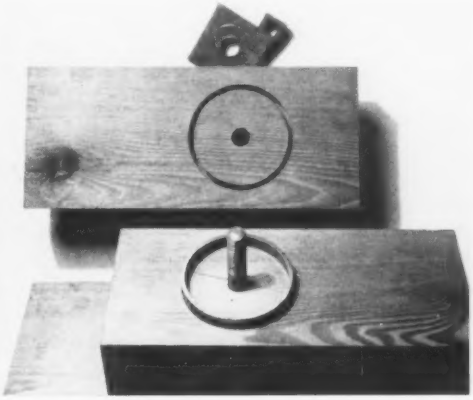
150 feet to small Gothic type arches that have been used to build small churches having surprising architectural appeal, resulting from using the arches as a conspicuous feature of the interior.

Laminated arches are fabricated to order at the factory, shaped to the function which they are to perform, with thick sections where stresses are concentrated; curved and tapered to follow side wall and roof slopes and to conform to the varying concentrations of load. Glued arches are classified as slow burning and require no special sheathing to guard against sudden failure in case of fire.

Hundreds of tons of steel have been saved during the period of preparation for war and since Pearl Harbor by the employment of glued laminated wood arches in factories, hangars, drill halls, and similar structures. Seagoing counterparts of the glued wood arch are the glued laminated ship keels and frames now going in hundreds of small naval craft to take the place of hewn timbers of large cross section.

The demand for moisture-resistant plywood construction for both airplanes and naval craft has led to new refinements in the fabrication of plywood that will inevitably be of permanent service in consumer goods. Perhaps the most striking development in this field has to do with the molding of weatherproof resin-bonded plywood to the curved shapes associated with marine architecture and the requirements of aerodynamics.

Where ordinary die molding will not suffice to produce parts having pronounced curvature or curvature in two planes, fluid pressure molding or so-called bag molding is resorted to. In this procedure strips of thin



RING-TYPE CONNECTOR IN TIMBER JOINT

A PT BOAT WITH HULL OF PLYWOOD

plywood coated with glue are laid up on the contours of convex or concave molds, and held in intimate contact with the mold by inflating or deflating a pressure bag or blanket against them until the glue has been set by heat supplied to the mold or bag.

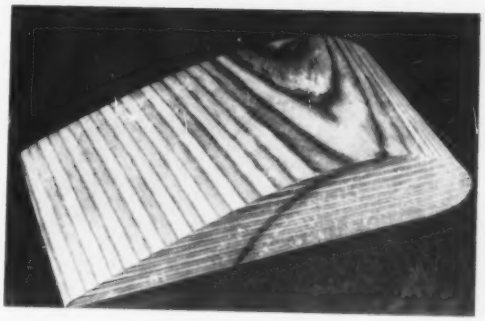
The principle can be illustrated by laying strips of paper over the contours of a teacup, covering the whole with a rubber toy balloon and exhausting the air until atmospheric pressure molds the rubber and strips to the contours of the cup; or by lining the inside of the cup (a concave mold) with the paper strips and inflating the toy balloon inside the cup.

Half fuselages, complete with bonded structural members, have been produced by bag molding, as have also small boat hulls, and many small aircraft units such as nose and tail cones, and air ducts and scoops. Complete planes made up of molded units have been built and successfully flown.

The most recent group of new wood products includes "impreg," "compreg," "hydroxylin," "papreg," and "uralloy," and commercial products similar to these laboratory creations. These materials, illustrating the scientific approach to modification of wood properties, show the most striking improvement over the usual properties of wood. This can be credited to the fact that all owe their origin to chemical or physical modification of the basic cellulose-lignin units of minute wood structure. All of these products base their invention on the knowledge that lignin, the cementing substance which surrounds and binds the cellulose fibers, can be plasticized by chemical treatment and made to flow, and on the fact that the physical behavior of wood can be made more stable by bonding added chemical groups to the cellulose of the fiber wall and the interfiber lignin. The result of proper application of these facts is to fortify wood against its primary shortcomings, pronounced moisture fluctuations and resulting swelling and shrinking, susceptibility to fungus organisms, and to fire, and in some instances deficiency in strength properties.

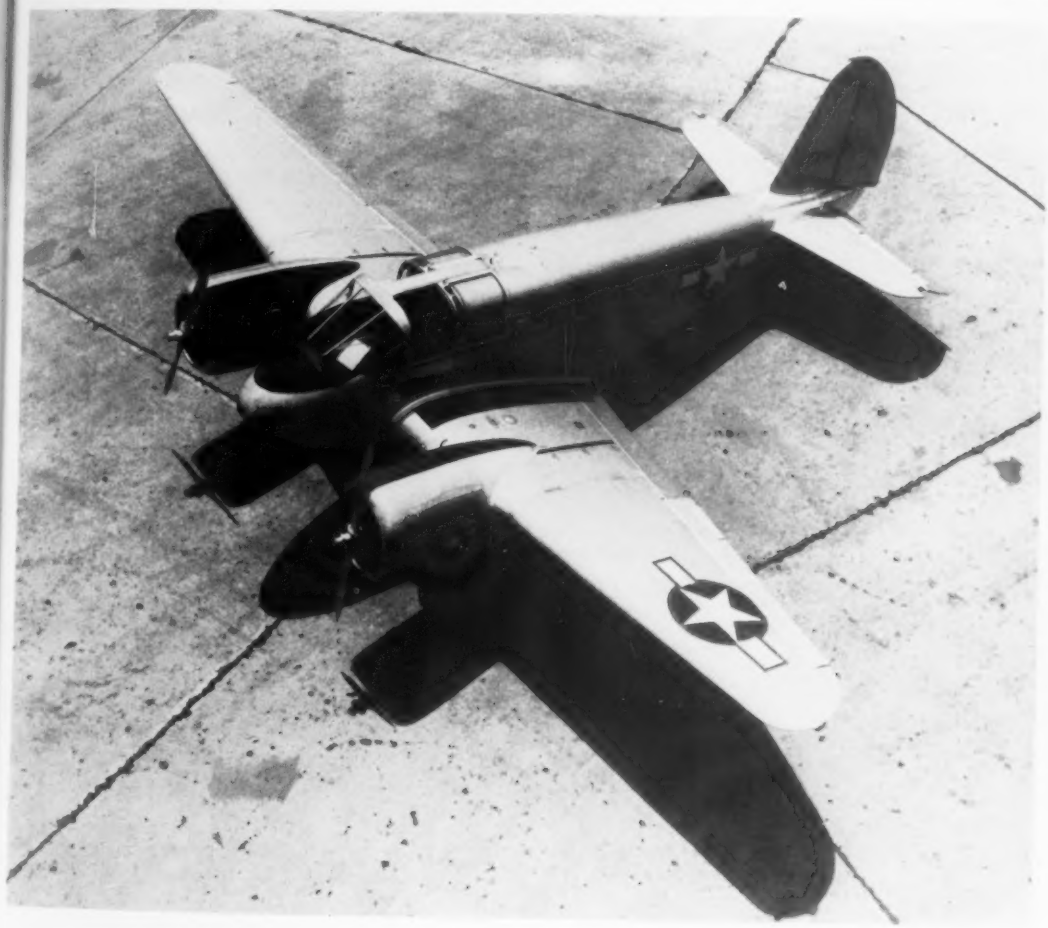
Impreg is resin-treated laminated wood with a high degree of moisture resistance (hence low swelling and shrinking) and im-

proved resistance to decay, fire, and to surface checking and weathering. In the manufacture of this product sheets of veneer are impregnated with a water solution of resin-forming chemicals, then dried and cured to cause the resin to polymerize or set within the wood. The treated veneers are laid up and hot-press bonded with resin glues to form a superior plywood. Success of the resin-impregnation treatment is dependent on selection of a resin and impregnation method that brings about not only introduction of resin to the hollow interior or lumen of the fiber but also a chemical bonding of the resins to the cellulose fiber wall itself. Thus the fiber is altered chemically and is no longer free to exercise fully its affinity for water and to swell as moisture is absorbed and to shrink when moisture is given up.



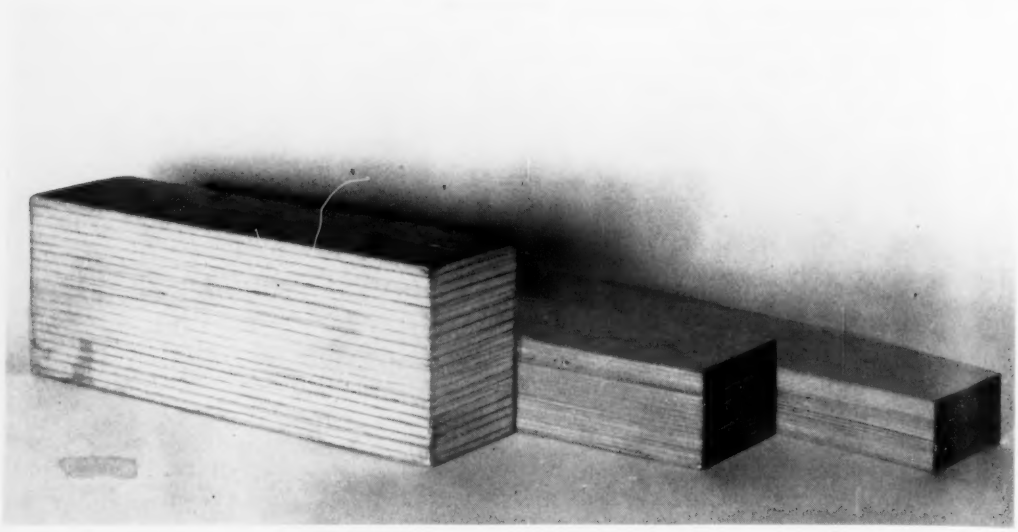
SECTION THROUGH COMPREG PROPELLER

Impreg resembles natural wood unless dyes are added to the impregnating resins. When light-fast dyes are found for impreg



BEECHCRAFT TRAINER SHOWING WOOD SUBSTITUTION

MAXIMUM SUBSTITUTION OF WOOD AND PLYWOOD FOR METAL HAS BEEN MADE IN BUILDING THESE TRAINERS.



UNCOMPRESSED LAMINAE AND TWO GRADES OF COMPREG

UNCOMPRESSED RESIN-TREATED LAMINAE AND COMPREG PRESSED AT 250 AND 1,000 POUNDS PER SQUARE INCH.

it will be possible to produce this durable material in colors completely permeating at least the outer thickness of veneer, thus obviating the need of any other finish.

Compreg in the making receives the same initial treatment as impreg but the simple curing treatment of the resin-treated sheets is replaced by hot pressing at varying pressures, depending on the properties desired. As the resin has a plasticizing effect on the lignin, the resin-treated wood compresses much more readily than untreated wood at the same pressures so that under moderate pressure the stack of veneer is compressed to a half or a third of its original thickness, thus acquiring added density. At the same time the resin diffused through the veneer sheets bonds them into a solid panel with considerably increased homogeneity. The resulting product has resistance to moisture, shrinking and swelling, fire, and decay equal to or better than impreg, but its density has been doubled and it has acquired a surface hardness of 60 to 90 as compared with that of plate glass at 100. The compreg takes a high gloss from the platens of the press, but the outstanding feature of the finish is that in effect it permeates the whole panel. Scratches on the surface can be removed by sanding and buffing without other treatment and cut surfaces can be brought to a high finish by similar treatment.

Compreg can be produced in thin sheets, amenable to molding techniques, or in thick blocks suitable for such purposes as the carving of propellers. As a matter of fact propellers of compreg are in production both by carving and by the molding from pretailored assemblies of resin-bonded and impregnated plies. Other aircraft parts, such as radio antennae masts, chart cases, and bucket seats, are in production.

The most immediate allure of compreg to the layman is its high gloss and its appeal to the sense of touch. It is hard, highly polished, heavy (specific gravity 1.0 to 1.3), and usually richer and darker in color than the wood from which it was laminated. Due to the concentrations of resin between plies, laminations running out on curved surfaces give an attractive synthetic "grain," independent of the actual grain of the wood. Shrinking and swelling of compreg are negligible, actual submersion tests of 50 days showing a swelling of only 3.6 percent. As compreg resists water, alcohol, and mild acids, and is not permanently spotted by these materials, its suitability for table and bar tops, chemical benches and similar uses is apparent.

It should perhaps be pointed out that compreg is a specialty product, not too costly for military aircraft, but not yet within the price range of common structural materials. On the other hand, especially if quantity production results in lowered costs, it seems reasonable to expect that in the postwar period compreg will come into its own for fine furniture items, architectural details, and similar uses where attractive appearance, high durability, strength, and easy maintenance are essential.

Combinations in which compreg faces of high durability are formed on cores of impreg or untreated wood in a single operation suggest one way in which both weight and cost can be reduced in sheet or molded materials having most of the advantages of full compreg.

Hydroxylin is wood's own entry in the field of low-cost, general purpose plastics. Made in two forms—molding powder and laminating sheets—both from hardwood wastes, it is classed as a low-cost plastic and has certain desirable properties, notably high acid resistance. Its future should be influenced by its performance in war material and by production experience gained by war contractors who will apparently be the first to use hydroxylin in quantity.

Made in only one color—jet, glossy, black—hydroxylin is in effect a lignin plastic with a cellulose filler. In making the molding powder, sawdust or wood chips are hydrolyzed with a weak acid or aniline to convert part of the cellulose in the wood to sugars which are removed by washing. This operation increases the percentage of lignin in the resulting "mash," which is dried and milled to a fine powder and to which a small amount of any one of a number of plasticizing agents may be added to lower the flow point of the lignin. The cellulose remaining in the molding mixture acts as a filler, just as wood flour does in many common phenolic molding materials, to increase the strength. Water

HYDROXYLIN MOLDING POWDER, EXPERIMENTAL MOLD, TEST MOLDS OF AN ASH TRAY

resistance of the mixture is dependent on the amount of lignin present. The cellulose derived sugars referred to as a by-product of the hydrolysis process could be broken down by fermentation to produce ethyl alcohol in operations large enough to guarantee continuous production.

Hydroxylin is relatively hard and strong, has high electrical resistance, and can be cut with machine tools like metal. It is relatively light in weight (specific gravity 1.40) and bonds well to metals such as brass, bronze, and aluminum. The hydrolyzed wood sheet can be laminated under heat and pressure to form, under double curvature if desired, a material that has promise for many uses.

Efforts of one war contractor to get into production with a hydroxylin battery box for military airplanes appear to be nearing success. In this case the wood-derived material will replace hard rubber (now out of the picture because of war scarcity) with a significant saving in weight because of the greater strength per unit weight of the hydroxylin.

Papreg, one of the most recently developed products of wood conversion to receive attention, is a high-tensile-strength, plastic-like paper laminate which is being tested for the production of stressed parts in aircraft as a substitute for light metals. Resin-impregnated paper laminates are by no means new, but papreg is unique in that among such laminates its strength properties are such as to merit serious attention, notably on the part of aircraft designers, for objects taking considerable stress. The significant technical development of papreg is being carried out by the Forest Products Laboratory with a view to its potentialities as a substitute for aluminum in military aircraft, hence detailed information on its production and on its properties remain in the realm of classified restricted information, available only to manufacturers and processors authorized by Government war agencies to receive such information to aid the national war effort.

PAPREG: LAMINATED, TREATED PAPER

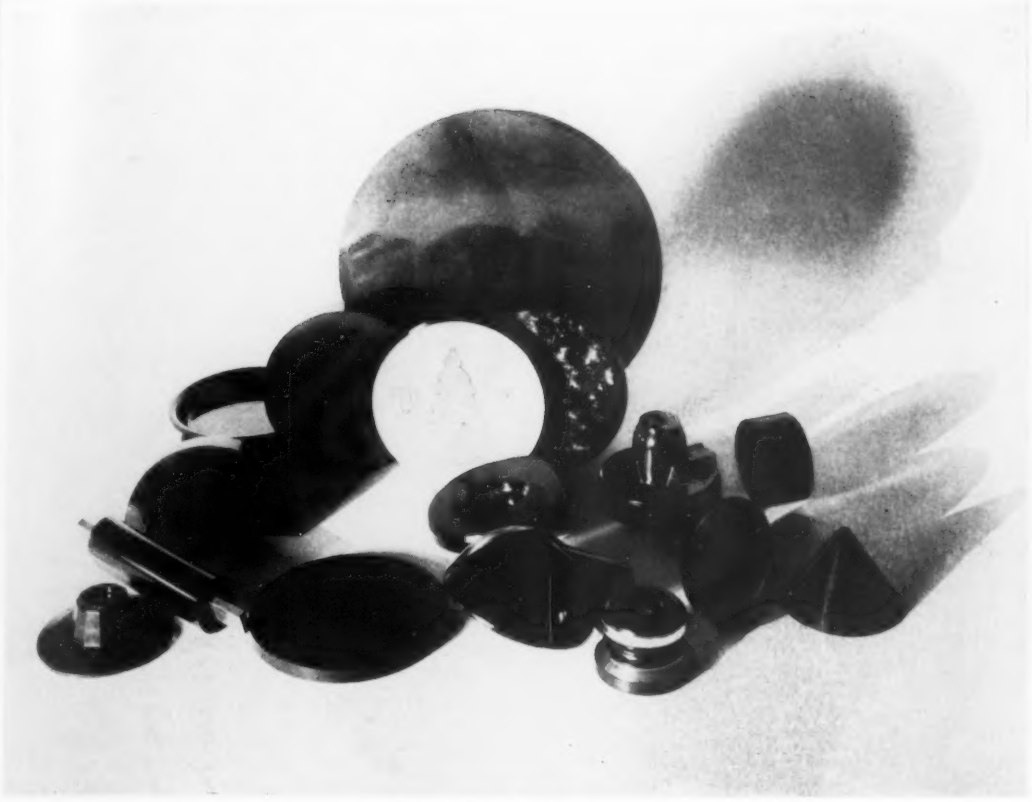
The following quotation from an official release sums up the information that is available to the public:

> An improved paper-base plastic equaling aluminum in tensile strength on a weight basis has been developed and is being produced experimentally in the form of aircraft parts, including wing ribs, wing tip skins, and control surfaces.
>
> Experimental data thus far obtained in laboratory tests indicate that the product has twice as great tensile strength as any paper laminated plastic hitherto produced; that it can be molded to desired shapes at temperatures and pressures and on equipment now used for making plywood; that it is resistant to moisture and remains extremely stable at both high and low temperatures, and that it is more resistant to scratching and denting than aluminum. The plastic has a smooth surface, eliminating the necessity for special finishes and coatings.
>
> Tests also indicate that it does not splinter, tear, nor flower out when pierced by bullets.
>
> The properties of papreg, which can be varied to meet special needs, also give promise for use in water craft ranging from small boats to cargo vessels, and in the hulls of flying boats.

Papreg is another product of high durability, strength, and stability that has obvious possibilities for consumer goods, particularly since it might be given a variety of decorative treatments. At present, however, little thought has been given to consumer uses; its future in this field will be determined by economic competition of the raw materials after the war.

Uralloy—urea-plasticized wood—has not reached a stage of refinement as advanced as the other products described, but it is capable of modification in ways that should make it practical for many postwar uses. Essentially the process of making uralloy consists in soaking green wood in a solution of urea, drying it, heating it to about the boiling point of water, and shaping it or bending it at this temperature.

This type of processing results in a prod-



EXPERIMENTAL MOLDED OBJECTS OF HYDROXYLIN

uct which is thermoplastic, that is, capable of being returned to its original shape on reheating, but a thermosetting product can be made by adding a resin-forming chemical to the urea solution and altering the subsequent treatment. The thermosetting type of uralloy retains its shape on reheating and has moisture resistance that is lacking in the thermoplastic form. Control of the thermosetting process can also be used to resinify the wood and produce simple hardening.

Initial experiments on uralloy were made with oak, which appears to be especially suited to the treatment. Other woods, however, have been made into various forms of uralloy with success.

In addition to the new products that have been mentioned there is an indication that it will be possible to make additional forms of moisture-stabilized wood without resort to full resin impregnation. It is also obvious that there are manifold possibilities of combining impreg, compreg, papreg, plywood, and untreated wood. Intriguing also is the prospect of surfacing light woods or other light filler substances with durable face plies to produce a variety of so-called "sandwich" materials. The success obtained with plywood-faced balsa in constructing the doughty British Mosquito bomber of daylight bombing fame will no doubt be the forerunner of a considerable line of "sandwich" combinations that will find their way into peacetime commodities.

Some new wood derivatives and new wood processing methods, not immediately applicable to war needs, lie dormant in chemists' notebooks. An example is the hydrogenation method for processing lignin, the binding constituent of wood that until recent years has been a good deal of a chemical mystery. By subjecting aqueous solutions of lignin from waste pulping liquor or other sources to hydrogen under pressure, a variety of alcohols, oils, and an alkali-soluble resin have been recovered. The alcohols in-

clude methyl alcohol (wood alcohol or methanol) and propyl alcohol, and previously unknown products of the hydrogenation include a hard, glossy, amber-colored resin that may prove useful for plastics and lacquers, and several derivatives of propylcyclohexane, some of which are thick viscous oils and others thin and toxic in nature. The apparent utility of these products has not been subjected to practical tests.

When the whole wood complex is subjected to hydrogenation, the lignin fraction is resolved into the components just described and the cellulose may be recovered in the form of a bleachable pulp of normal fiber length.

Certain products and uses of wood which return to public attention again and again with the impact of novelty are not emphasized here because they are not new. There is at least a quarter of a century of know-how and experience behind such developments as silk-like (rayon) and wool-like textile fibers from wood, automotive fuel from wood or charcoal, ethyl ("grain") alcohol and edible sugars from wood. Rayon, of course, has been manufactured largely from wood in this and other countries for years to the extent of several hundred million pounds per year. The other forest products mentioned have been and now are in use in parts of the world where economic conditions permit.

The encouraging aspect of most of the new wood products mentioned is the progress that has been made in overcoming inherent characteristics of raw wood that have limited the scope of competition with other materials. Furthermore, the prospect for continued improvement of the products and the refinement of others, already being developed under the mantle of military security, is most encouraging.

There is sound scientific basis for optimism regarding the future of wood. Research at the Forest Products Laboratory and in colleges and industrial laboratories over the last third of a century has filled in long-sought details on the fundamental chemical and physical structure of wood, especially for the lignin component, and has provided the approach to new conversion processes and better control of established processes. The most promising products of wood now finding their way into important military uses and shortly to serve civilian needs had their beginnings in fundamental research, not in the uncertain resources of unguided imagination or cut-and-try empiricism. The properties of wood can now be controlled and balanced one against the other with certainty.

COSMIC TERRESTRIAL RESEARCH

By HARLAN T. STETSON

A FEW years ago a small, enthusiastic group of business men and scientists met at luncheon to discuss plans for a new venture in science connected with the Massachusetts Institute of Technology. They forgot for the moment problems of corporations, finance, and administration to consider a new and coming field of research in cosmic terrestrial relationships—a subject made vital by the recent results of observations and deductions concerning the effect of phenomena originating outside the earth upon the science of the earth and its atmosphere. The marshaling of an array of facts demonstrating the effect of the sun's radiation upon the upper atmosphere, upon radio communication, and upon the earth's electric and magnetic fields opened up new possibilities of research in a little explored territory.

At the close of the luncheon sufficient funds had been pledged to insure, on an experimental basis, the continuance of basic research in this new field of investigation for a sufficient period to justify the venture. As a result of this conference, a new Laboratory for Cosmic Terrestrial Research (Fig. 1) was constructed in the suburbs of the Boston metropolitan area where observations and studies could be continued at an ideal location.

The site of the new laboratory was selected after about a year of careful study of the environs of Boston in order to find a place having suitable conditions for atmospheric electric observations and easily accessible to the Massachusetts Institute of Technology with which the work at the Laboratory is associated. The laboratory is located two miles from the center of the town of Needham in a sparsely settled residential district, ten miles southwest of Boston and industrial Cambridge. The unusually good conditions

FIG. 1. NEW LABORATORY FOR COSMIC TERRESTRIAL RESEARCH, NEEDHAM, MASS.

for radio reception have proved that the location is eminently satisfactory.

The main building comprises approximately 2,500 square feet of floor space, not including the basement in which the instrument shop is located. The building is of masonry construction and the architecture is functional modern. Interior views are shown in Figures 2 and 3. The laboratory is primarily intended for the "geophysical investigation of such relationships as may exist between cosmic phenomena exterior to the earth and such terrestrial phenomena as may result from or vary with changes in the earth's environment." A large part of the observational work being carried on relates to problems of solar radiation and atmospheric electricity, with applications to communications. The general integrated program is being carried forward under six principal subdivisions: solar studies; radio studies; auroral studies; the earth's electric field; cosmic ray observations; and certain biological phenomena.

The Sun and Radio. Since a discussion at considerable length of the effects of solar radiation and solar disturbances upon the ionosphere and radio communication conditions has previously appeared in the June, 1942, issue of *The Scientific Monthly*, less space will be devoted here to this subject than its importance would otherwise warrant. The relationship of solar disturbances, as conveniently marked by sunspots, to the electrical state of the upper atmosphere necessary for satisfactory radio communication is now so generally recognized that this part of the program of the Laboratory receives special emphasis. The long series of observations of field strengths of radio reception in the broadcasting band, first undertaken by the author in 1926, now approximates 75,000 hours, which has provided probably the largest amount of homogeneous field strength data at broadcast frequencies in existence.

The analysis of this material has shown not only a general trend consistent with the in-

FIG. 2. MAIN OFFICE AND FILING ROOM OF THE LABORATORY

FIG. 3. THE CONFERENCE AND DIRECTOR'S ROOM

verse of the sunspot curve, but has exhibited remarkable instances of long fade-outs while sunspots of unusual size pass across the line from the center of the sun to the earth. The remarkable increase in radio fields in passing from daylight to darkness, and the marked seasonal variation which follows the changing declination of the sun from summer to winter, are probably the most pronounced demonstrations of radical changes in the electrical state of the upper air under the influence of the sun. A wholly unexpected annual variation has been discovered that is not explained by any seasonal effect. It seems to parallel closely the known annual variation in the amount of ozone in the air.

Extended studies have indicated that there is an optimum value of the ionization of the radio ceiling for the best conditions for radio transmission. Before this optimum value is reached, the reflection of the sky wave is too feeble for good signal intensity. When the optimum value is exceeded, the ionization of the layers of the atmosphere below the reflecting ceiling becomes so great as to absorb much of the energy in the radio waves and therefore again reception is below par. This indicates that a certain amount of solar activity, evidenced by a critical number of sunspots, is best suited for certain communication conditions; excesses or deficiencies in the number of sunspots with respect to the critical value result in a deficiency in radio communication. Just what amount of solar activity is necessary in the long run to produce the most favorable transmission conditions has yet to be determined.

With the added space made available at the new laboratory, at the end of 1941 we began recording the higher frequency waves such as those used in transoceanic communication (Fig. 4). Unlike the broadcast radio waves, these waves are not heavily absorbed in daylight and consequently observations of them can be made twenty-four hours a day, year in and year out.

While the broadcast waves improve many fold with the increase of darkness after sunset, the high frequency or short waves notably deteriorate from sunset to shortly before

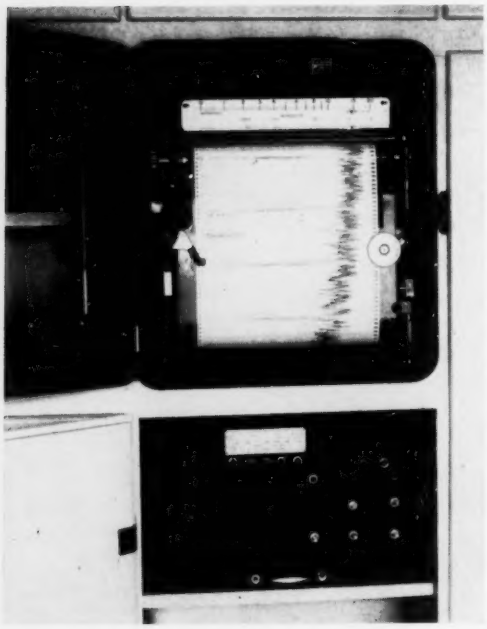


FIG. 4. MICROMAX RECORDER
USED FOR REGISTERING RADIO FIELD STRENGTHS ON HIGH FREQUENCY WAVES FROM A DISTANT STATION.

dawn. At sunrise when the solar radiation first strikes the upper atmosphere one hundred and fifty miles above the earth, the molecules of oxygen and nitrogen become instantly ionized and the reflected radio waves of a frequency of 5,000 kilocycles increase their strength over a hundredfold in the space of a very few minutes. As the sun rises higher above the horizon, the increase in ionization in the lower levels of the atmosphere absorbs the energy from these radio waves and reception deteriorates until noon. As the sun descends toward the western horizon, positive and negative ions in the air recombine and neutralize the absorbing effects in the lower layers, with the result that field strengths increase again until sunset.

Reception at even these high frequencies, however, may be totally impaired, as our records have so many times shown, when large sunspots pass over the portion of the sun facing the earth. It is truly remarkable that with the use of radio apparatus it has become possible to trace so intimately the effect of solar changes upon the electrical state of the upper air so relatively close to the surface of the earth which man inhabits.

Effect of the Moon. The large amount of radio data which has accumulated in the observational part of our program has made it possible to investigate what effect, if any, the moon may have upon the electrical state of the upper air. As far back as 1931 the writer showed evidence of a tidal effect of the moon upon the ionosphere or radio ceiling. Subsequent studies based on accumulating data seem to establish definitely that the electrical state of the upper air experiences variations somewhat similar to the tidal variations of the ocean caused by the moon. It was not believed that moonlight, which is only 1/300,000 as intense as sunlight, could in any way be responsible for this change. It appeared more probable that the gravitational tides set up in the atmosphere by the moon, or possibly electronic tides caused by an electrical charge on the moon different from that on the earth, was the determining factor. Some time later E. V. Appleton, a distinguished English scientist, obtained evidence from quite different observations that lunar atmospheric tides affect the radio.

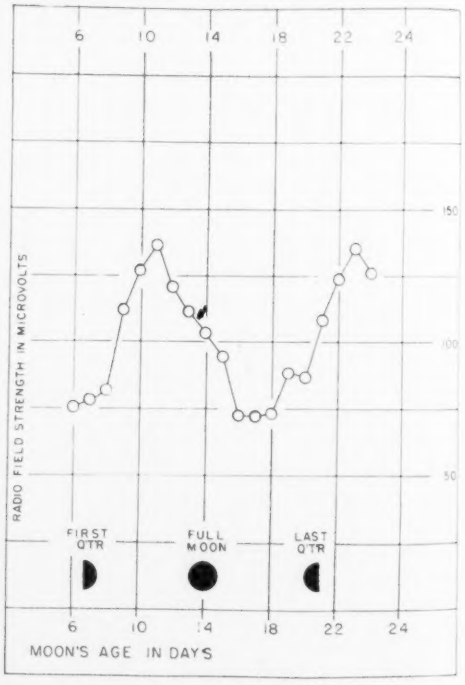


FIG. 5. RELATION OF MOON AND SUN APPEARS TO BE A FACTOR CAUSING VARIATIONS IN FIELD STRENGTHS IN THE BROADCAST BAND. CURVE IS BASED ON RECORDS EXTENDING OVER A SIX-YEAR PERIOD.

Meanwhile, radio operators reported marked variability in radio reception with the changing phases of the moon. Although apparently unreasonable, the reports were so persistent that it seemed worth while to make an extensive study of our broadcast radio data to see whether or not there were any adequate grounds for concluding that such effects exist. It was thought that our measured field strengths would show no systematic change whatever with the changing illuminated surface of the moon. Such, however, was not the case. Contrary to all expectations, our records showed a definite improvement in radio reception from new moon until about two days before full moon, and a deterioration thereafter until near the moon's last quarter. Then there follows a subsequent recovery until two days after the last quarter of the moon (Fig. 5).

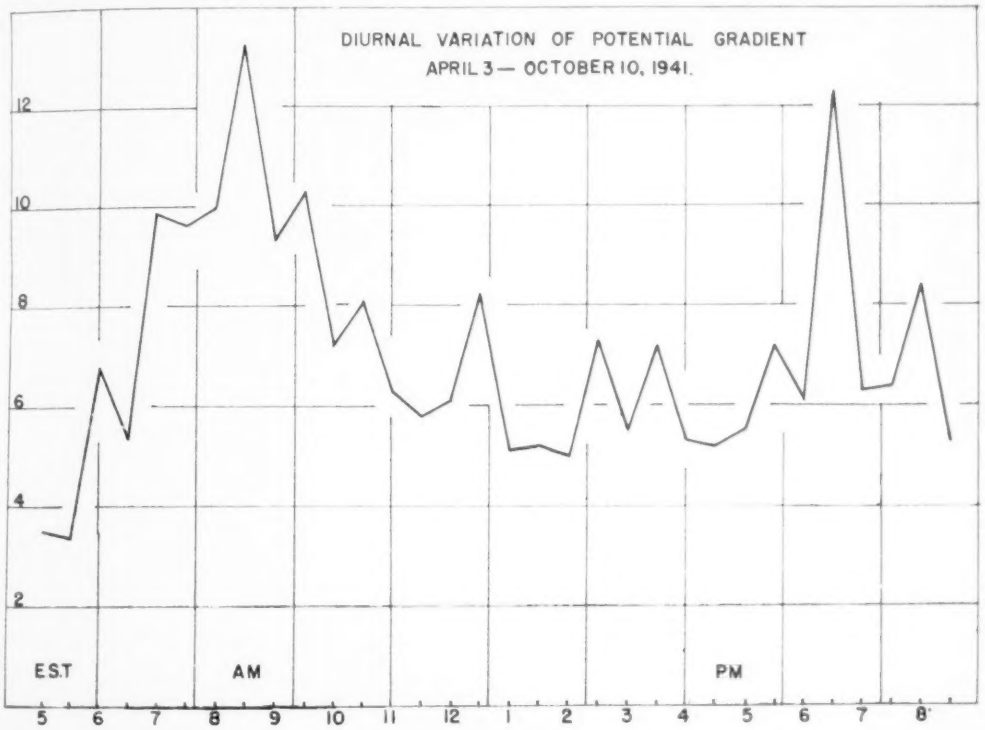


FIG. 6. DIURNAL VARIATION IN THE ELECTRICAL POTENTIAL OF THE ATMOSPHERE

These results have led to a somewhat speculative hypothesis to account for the observed phenomena that, should it become substantiated, would appear to be revolutionary in our thinking about cosmic terrestrial relationships. This hypothesis rests upon the fact that the moon has no atmosphere and that its naked surface is exposed to an intense bombardment by the extreme ultraviolet radiation from the sun, and also by any other kind of radiation, such as electrons or high energy particles, which the sun may emit. Almost any substance subjected to ultraviolet radiation is known to emit electrons. This is the so-called photoelectric effect. Since the earth's atmosphere absorbs all this intense solar radiation, the really high-energy radiation never reaches the earth's surface. Since the moon is directly bombarded from the sun, its surface must be emitting electrons, some of which will penetrate into the earth's upper atmosphere causing ionization, which in turn could be expected to affect radio reception.

If the ionization is increased to and beyond an optimum value, radio reception will at first improve and then fade in the intensity with which it is received. This is exactly in accordance with our extensive analysis based on many thousands of hours of observational

data. That the observations show the existence of such an effect only on the side of the earth towards the illuminated surface of the moon appears good corroboration for the hypothesis. What is even more exciting is that this lunar effect is much more pronounced during the years of most numerous sunspots when radio observations tell us that the sun is actually sending out most energy in the ultraviolet.

There is, moreover, increasing evidence that radiation resembling x-rays may be emitted by the outer atmosphere of the sun. Such x-ray radiation striking the moon would in turn excite x-ray radiation from the elements in the moon's surface itself. The x-rays that are scattered or emitted in the direction of the earth might in turn be a factor in increasing the ionization in the earth's upper atmosphere, for x-rays are known to ionize air.

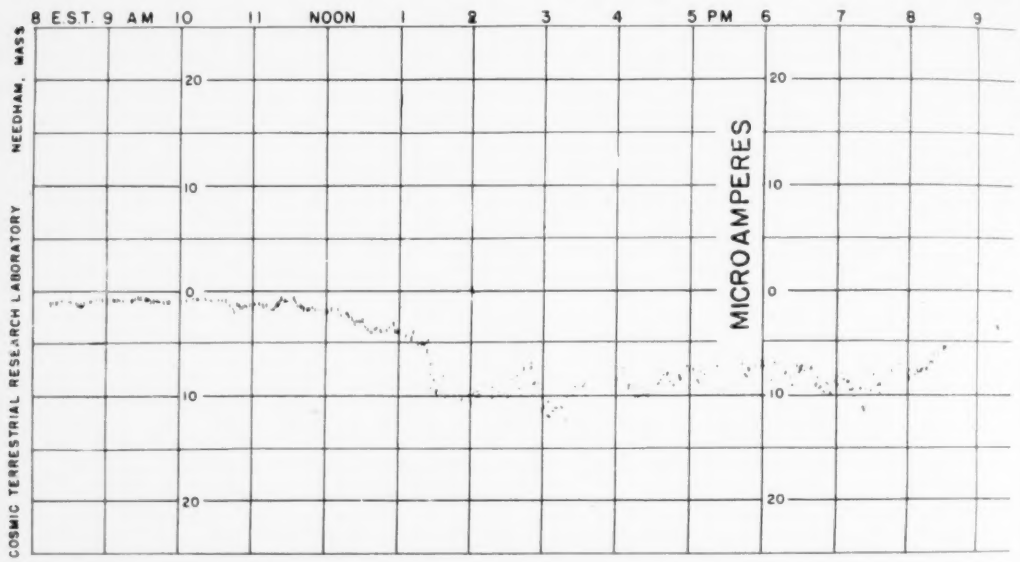


FIG. 7. ELECTRICAL DISCHARGE RECORD DURING STORM OF OCT. 26, 1943
MADE WITH POINT DISCHARGE APPARATUS, SHOWING A SKY-TO-EARTH CURRENT OF TEN MICROAMPERES.

The emission of photoelectrons from the lunar surface might be expected to create an electrical charge on the moon different from that on the earth. When the moon is between us and the sun, this charge could well alter the speed and direction of charged particles emanating from the sun in the earth's direction, just as the grid in a radio tube may accelerate or retard electrons emitted from the filament in their passing to the third element of the tube. This picture, therefore, introduces us to a possible new science of *celestial electronics* that may be destined to play an important part in the field of cosmic terrestrial relationships in the coming years.

Air Beacon Observations. In addition to such investigations as those already described, mention should be made of systematic observations that are being made of the apparent shift in direction of the beam of a commercial radio air beacon located ten miles from the laboratory. As is generally known, the antenna of a radio air beacon is so arranged that the Morse Code signals for the letters A and N are sent out from adjacent quadrants, such as Northwest and Southeast. A pilot homing exactly on the beam hears neither of these signals but a constant hum resulting from the overlapping of both signals received simultaneously and with equal intensity. If the pilot is north of the axis of the beam, the dot-dash of the letter A predominates; if he is south of the beam, the dash-dot of the letter N predominates. The relative strength of these two signals heard from a point off the axis is, in a measure, an indication of how far the plane

FIG. 8. SOILLESS GROWTH OF MUSTARD PLANTS 38 DAYS FROM SEED

PLANT AT RIGHT SHOWS APPARENT STIMULATED GROWTH UNDER A POTENTIAL OF EIGHTY NEGATIVE VOLTS. A DUPLICATE SCREEN OVER THE CONTROL SPECIMEN ON THE LEFT WAS WITHOUT ANY ELECTRICAL CHARGE.

may be from the axis of the beam. The Needham laboratory lies slightly north of the axis of the beacon under observation. The field strength of the A signal compared with the N signal is measured hourly. Every effort is made at the sending antenna to maintain the output of the two signals constant, yet the ratio of these two signals as observed at the laboratory shows definitely a diurnal and seasonal variation. The ratio of A/N rises steadily after sunrise to a maximum value shortly after noon and thereafter diminishes toward sunset. Under abrupt meteorological changes the value of the ratio has been found to change systematically with the passing of a storm center. If one were to interpret the change in the ratio of A/N as equivalent to a change in the bearing of the direction of the beam, it can be said that during severe storms the apparent direction of the beam has been observed to shift by as much as 7° from its normal location with respect to the laboratory.

Careful consideration has been given to the possibility of fortuitous changes at the beacon itself, including the possible effect of unequal electrical insulation in the antenna system during rain or snow. The results, however, more definitely point to dielectric changes in the lower atmosphere or changes in ionization conditions in the tropospheric layers. Irrespective of any practical considerations that might be applicable to problems of aviation, it is believed that further investigations of this nature may yield important information as to atmospheric-electric conditions that may correlate with meteorological or other phenomena under observation at the laboratory.

Earth's Electric Field. The magnetic field of the earth has been known since the early writings of Gilbert in 1600. Many detailed surveys of it have been conducted because it is important that navigators know the variations of the compass. For more than a hundred years the earth's magnetic field has been known to vary with sunspots. The explanations for this relation became apparent when radio studies revealed the existence of the highly electrified shell of the earth's atmosphere, known now as the ionosphere. Electrical charges moving aloft induce magnetic currents in the earth, thus producing the slight variations in the compass needle that accompany outbreaks of sunspots.

It is probably less widely appreciated that the earth likewise has an electric field and probably carries a considerable electrical charge. Since we live on the surface of the earth it is difficult to determine the nature or the magnitude of this charge on our planet, but suitable instruments make us aware of the electrical field existing between the surface of the earth and the atmosphere above. Near the ground, during fair weather, this field amounts on the average to between 100 and 150 volts per meter. A six-foot man standing erect bridges the gap between the ground and the air at the crown of his head corresponding to a difference of potential of about 250 volts. This electrical potential between the ground and the atmosphere not only increases with height to a certain limiting value, but it is also known to vary with the time of day, the season of the year, and possibly also with the sunspot cycle. Furthermore, electricity is constantly flowing from the air to the ground. The amount is about 1000 amperes for the entire surface of the globe. What maintains this constant uni-directional flow or whether or not it is everywhere uni-directional is one of the puzzling problems of atmospheric electricity. With the establishment of the Laboratory for Cosmic Terrestrial Research, suitable apparatus for measuring the potential gradient was installed. The apparatus consists of a Wulf electrometer which measures the charge on a horizontal brass rod extending at a distance of about six feet above the ground. This rod takes up the electrical potential of the atmosphere in the immediate neighborhood by reason of a slight emanation from radioactive material in the so-called "collector" at the outer end of the rod. The collector has been supplied through the courtesy of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The electrometer is read hourly through the day and occasionally through the night.

Observations so far collected have indicated a characteristic diurnal variation in the atmosphere's electrical potential. There is a rise in the early morning to a maximum at about nine o'clock, Eastern Standard Time, and a subsequent diminution to noon. This decline is followed by a second rise during the interval from six to seven P.M., Eastern Standard Time, after which the potential gradient falls to midnight (Fig. 6).

Observations made during the celebrated cruises of the non-magnetic yachts GALILEE and CARNEGIE, 1905–1916, revealed that over the oceans there is a distinct diurnal variation exhibiting a maximum at eighteen to nineteen hours Greenwich time, no matter in what longitude the observations were made. For this remarkable phenomenon no adequate explanation has yet appeared. There is some indication that it may be related to the asymmetry of the earth's magnetic field.

In connection with atmospheric-electric observations a device for automatically recording silent electrical discharges taking place between the sky and the earth has also been installed at the Needham Laboratory. The continuous daily recordings, which have accumulated rapidly, indicate rather definite relations between the occurrence of such discharges (not including thunderstorm disturbances) and meteorological conditions. Rainstorms are in most instances accompanied by the apparent flow of electricity from the earth to the sky of an intensity of five to ten microamperes (Fig. 7). Snow is likewise accompanied by similar discharges, often reversing direction at intervals of from a few minutes to an hour or more. Abrupt meteorological changes have in rare instances been accompanied by earth-sky currents of from 50 to 60 microamperes with frequent reversals of direction. Careful studies of our records, however, have indicated no abnormal sky-to-earth discharges in the lower atmosphere at times of the displays of the aurora when the high atmosphere is turbulent with electric pyrotechnics. What relationships may exist among these sporadic atmospheric discharges, the potential gradient, radio static, and ionization phenomena are not yet known, but accumulating data offer increasing information for such a study.

Electric Field and Plant Growth. We are well aware of the dependence of biological growth and behavior upon solar radiation and meteorological conditions. Douglass has long since demonstrated from his life-long study of tree-ring patterns that the

solar cycle is reflected in the growth of trees. This is particularly demonstrated in selected forests of the Arizona pines and of the California sequoias. The phenomena connected with phototropism in plants have in certain instances been definitely associated with certain regions of the solar spectrum eliciting optimum response. The germination of seeds of particular species has been found dependent upon a rather critical exposure to ultraviolet light. Little has yet been done in the way of investigating possible effects of electrical fields upon plant behavior. One wonders if the varying potential gradient of the earth's field has anything whatever to do with plant growth. At least this is another one of the varying parameters with which the biologist may yet be concerned. Some experiments have been made in this direction at the Laboratory for Cosmic Terrestrial Research where tomato plants started from seed and also mustard plants germinated under laboratory-controlled conditions appear to have shown definite response to a negative potential of but relatively few volts.

In the experiments so far conducted, soilless growth has been adopted, utilizing a nutrient solution recommended by the Smithsonian Institution. In every case the nutrient solutions have been fed automatically to both the experimental plant and the control, care also having been taken to maintain the same illumination of both specimens. Figure 8 shows mustard plants thirty-eight days from seed. The experimental plant on the right was subjected to a potential gradient of eighty negative volts between the root and a screen 30 centimeters directly above the plant. The control on the left was not subjected to a potential gradient. Similar differences in growth occurred in tomato plants.

In the above instances, the voltage was arbitrarily chosen. In order to attempt to discover the optimum potential gradient for greatest growth, a hydroponic trough was constructed in which plants were grown under a sloping screen to which was applied 190 negative volts with respect to the roots.

FIG. 9. PLANTS GROWN HYDROPONICALLY UNDER AN ELECTRIC FIELD GRADIENT
SILHOUETTED GROWTH CURVE SHOWS POTENTIAL GRADIENT OF 4 VOLTS PER CM. AS OPTIMUM FOR GROWTH.

The photograph (Fig. 9) is a silhouette of the growth resulting forty-three days after germination. It will be observed that at the extreme left where the potential gradient was high, the growth was markedly stunted. At the extreme right where the potential gradient was relatively low, the growth was not far from normal expectancy. A little to the right of the center of the trough, the maximum growth was obtained. A measure of the distance from root level to the charged screen in a vertical direction at this point revealed a potential gradient of approximately four volts per centimeter, which is apparently the optimum value of the potential gradient for greatest growth.

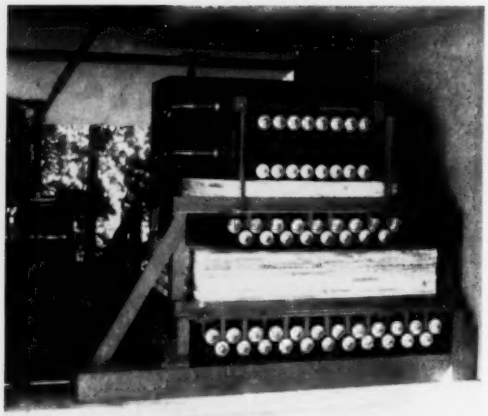


FIG. 10. COSMIC RAY APPARATUS
72 GEIGER-MULLER COUNTERS ARRANGED IN 3 BANKS; 2 TONS OF LEAD IN ABSORBING LAYERS SORT THE RAYS.

Many repetitions of the experiment should be performed under varying conditions before drawing conclusions. These preliminary attempts, however, may well lead one to speculate as to whether variations in the atmospheric potential known to exist have a significant effect upon biological phenomena in any way.

Cosmic Ray Investigations. The newest piece of apparatus to be added to the Needham Laboratory equipment is a multiple cosmic ray counter recently installed in connection with Massachusetts Institute of Technology's part in a program tied in with The University of Chicago and other institutions (Figs. 10–11). This elaborate equipment was especially built for the project by experts at the Ryerson Physical Laboratory of The University of Chicago. Seventy-two Geiger-Muller counters fed through an 88-tube amplifier cause the cosmic rays to click their way to a printing recorder that automatically counts hour by hour the numbers of the "rays" reaching the Earth from somewhere out in space.

The exact origin of cosmic rays is still one of those unsolved mysteries of science. Some of these "rays" are unquestionably electrons; others consist of mesotrons and protons. All are traveling at very high velocities. Some are more penetrating than others. The new machine sorts these rays into "soft," "medium," and "penetrating" radiations, and records hourly their "counts" in three divisions of the cosmic ray spectrum. Here, as in myriad other applications, electrons in vacuum tubes have been put to work gathering data.

To differentiate true cosmic rays from gamma radiation emanating from radioactive materials in the earth and air, or from strays that may enter at oblique angles, some means must be provided for insuring that the ionizing radiation actuating the Geiger tube comes from a point near the zenith. This is done by a tandem series arrangement of two or more counter tubes placed in a vertical plane so that the cosmic ray entering the first counter from directly above may also actuate the counters immediately beneath. When two or more of these counters and their input amplifiers have been actuated practically simultaneously, the current will have been closed through all input amplifiers belonging to counter tubes in the same vertical plane; then and only then will the appropriate relay respond. Stray rays coming in obliquely will activate one or the other of the amplifiers but not all simultaneously. A vertical ray on the other hand will pass through both or all within practically the same instant. Such an arrangement of counter tubes and vacuum tubes is termed a coincidence amplifier. Much cosmic ray apparatus now in use is equipped with coincidence amplifiers.

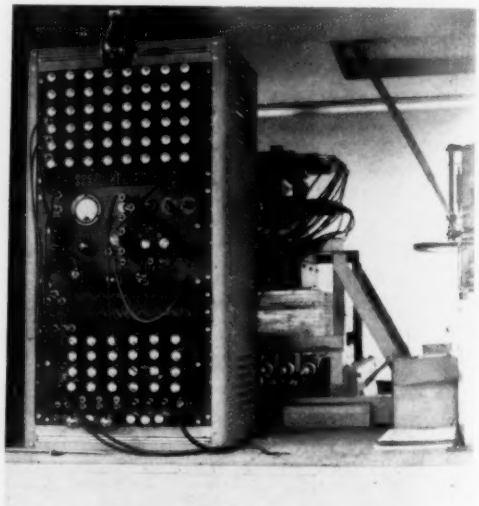


FIG. 11. THE 88-TUBE AMPLIFIER
SENDS IMPULSES FROM COUNTER TUBES TO RECORDER.

Since cosmic rays differ very greatly among themselves in the amount of energy carried, it is important to have some means of differentiating those of high penetrating power from the softer rays. This is accomplished by utilizing, as in the present arrangement, three separate banks of counters with different amounts of lead separating the banks.

The top bank, for example, which will register the softer rays, will be actuated by all cosmic radiation of sufficient intensity to penetrate the atmosphere and the walls of the counter tube. Below the top bank, sheet lead ten centimeters in thickness stops these soft rays from actuating the second bank of counters beneath. Cosmic rays of sufficient penetrating power to pass through this 10 centimeters of lead will actuate the counters in bank two. Separating bank two from bank three, the lowest layer of counters, there is an additional twenty centimeters of lead plate so that, when the counters in the bottom layer are activated, the cosmic rays responsible for the operation of these counters must have penetrated through thirty centimeters of lead altogether. These are very penetrating rays.

The counters (Fig. 10) and the 88-tube amplifier (Fig. 11) are housed in a shelter on the grounds of the Laboratory. The elaborate recording and printing mechanism is stationed inside the main laboratory, and is operated by a synchronous clock. Should any momentary interruption of the power supply occur, the apparatus is automatically cut out and must be manually reset. This is to avoid any uncertainty as to the correct interpretation of hourly counts.

So interrelated are the problems in these many different but allied fields of science that no one specialist in any one field can hope to cope with all their implications. Astronomy, meteorology, atmospheric electricity, geophysics, communication engineering, and even biology meet in common territory when we seek the solution of problems in cosmic terrestrial relationships. Here specialists must concern themselves with the synthesis of knowledge gleaned from the sky above to the earth below.

Too long, perhaps, has science delayed in apprehending the cosmic environment of the earth as an important factor in the geophysics of our planet. Furthermore, we are becoming increasingly aware that man himself is a highly articulated organism whose activities and even whose metabolic processes are quite dependent upon the quantity and quality of sunlight and the circumstances of his terrestrial environment. Even all life has revealed itself as electrical in nature. The mysterious electron, a fundamental building block of matter which dances in our radio tubes to the tunes of our favorite orchestra, dances likewise in the atoms of the distant stars, in the vast interstellar spaces, and in man himself. We are indeed entering upon a strange new world of thought in science—perhaps as strange as was the Copernican doctrine of a heliocentric universe to the medieval mind of three hundred years ago.

What implications the future may hold we cannot now foresee. Perhaps a note of caution should be sounded lest the over-enthusiastic indulge in unwarranted speculation. To the less imaginative Horatios:

> There are more things in heaven and earth, Horatio,
> Than are dreamt of in your philosophy.

PRESIDENTS OF STATE UNIVERSITIES

By JAY C. KNODE

A STUDY of the academic backgrounds of state university presidents of the year 1941 compared with similar backgrounds of the presidents of the same institutions in 1916 shows certain definite trends. The data used herein were obtained from the two corresponding editions of *Who's Who in America*. The membership list of the National Association of State Universities for October 31, 1941, contained the names of fifty-two administrative heads of institutions and systems. Forty-seven of these presidents of universities in the continental United States (including two presidents-elect) were compared with the heads of the same institutions twenty-five years earlier.

The first item observed was the positions from which presidents stepped into the headship of a university. These positions were classified as those of professor, dean or director, vice-president, president of another educational institution, and positions not connected with higher education. The figures for the two years are shown in Table 1.

TABLE 1

DISTRIBUTION OF FORMER POSITIONS OF PRESIDENTS OF 47 STATE-SUPPORTED UNIVERSITIES IN 1916 AND 1941

Position	1916	1941
Professorship	17	9
Dean or directorship	14	19
Vice-presidency	0	5
Presidency of other institution	9	6
Other than college work	7	8

Deanships included those of administration and instruction; directorships included one of an agricultural experiment station. Others were of the kinds familiar on most large campuses. The positions outside college work in the 1916 list included the directorship of religious education for the national organization of one of the Protestant churches, but the holder of this position had been a former university president. Similarly, one in the 1941 list went from the position of city manager, but had previously held a professorship of municipal administration, and another, though vice-president of a large commercial concern when elected, had been an associate professor of business. A few of those not connected with higher education were called from judgeships and the practice of law, but more went from positions connected with public school systems.

Table 1 is computed upon the basis of the immediately preceding positions left by presidents when they assumed headships of state-supported universities. The striking point here is the increase in emphasis upon previous educational administrative experience. The professorship as a source of presidential timber dropped virtually 50 percent; deanships and directorships rose more than 35 percent, and vice-presidencies 100 percent. Of the 39 coming directly from college positions in 1941, 74.4 percent had had administrative experience; in 1916, of the 40 coming from college positions 57.5 percent had administrative backgrounds in higher education.

The study was extended to include the two immediately antecedent offices. It was then found that only three of the 1941 list had not had executive experience in either of their two preceding positions. These men came from professorships of economics, history, and physics. In the 1916 list fifteen of the seventeen listed in Table 1 had not done administrative work in either of their two previous positions. The list included such men as: William Lowe Bryan, from Greek and philosophy; Livingston Farrand, from psychology and anthropology; Jacob Gould Schurman, from philosophy and English literature; Henry Suzzalo, from philosophy of education; Charles Richard Van Hise, from geology; and Benjamin Ide Wheeler, from Greek, Latin, and German. Another item of interest is that out of the 1941 list four men at some time previous to their election to a presidency had been deans of schools of business and one had been a

comptroller. These categories did not appear in the 1916 list.

A study of degrees held by presidents shows little variation in the pattern for the Ph.D., but the complete disappearance of the honorary D.D. and the appearance of advanced earned degrees in law and education in the contemporary list mark a new shift. A numerical comparison is made in Table 2.

TABLE 2

HIGHEST EARNED DEGREES HELD BY PRESIDENTS OF 47 STATE-SUPPORTED UNIVERSITIES IN 1916 AND 1941

Degree	1916	1941
Ph.D.	23	21
Master's Degree	13	12
Bachelor's Degree	7	6
S.J.D. or J.D.	0	2
M.D.	1	0
Ed.D.	0	1
LL.B.	0	4
C.E.	1	1
M.E.	1	0
No Degree	1	0

In 1916 two of the holders of the master's degree and two of those with the bachelor's degree held honorary D.D. degrees. No one held this distinction in 1941. Further, it should be pointed out that, in addition to the six men indicated as holding law degrees in 1941, two others with the Ph.D. degree had also earned the LL.B., making a total of 8, or a little more than 17 percent of the total of 47 possessing degrees in law. Among the 1916 list no one held such a degree, but the one president without a degree had been advanced to his office from the bench of a Circuit Court of Appeals.

The third comparison undertaken was relative to the academic fields of interest of the two groups. It was possible to trace this through the teaching done by 37 of the 1916 group and by 39 of the 1941 group. Subjects were grouped among humanities, social sciences, natural sciences and mathematics, and professional subjects. Some difficulty in classification was encountered owing to the fact that several men had divided their teaching loads, but approximate results are shown in Table 3 by percentages.

TABLE 3

FIELDS OF TEACHING OF 37 PRESIDENTS OF STATE-SUPPORTED UNIVERSITIES IN 1916 AND OF 39 PRESIDENTS IN 1941

Field of Teaching	1916	1941
	Percent	Percent
Humanities	32.9	7.7
Social Sciences	28.6	30.8
Natural Sciences and Mathematics	27.1	12.8
Professional Subjects	11.4	48.7

Here, perhaps, is the most striking evidence of the change in the complexion of state university administration. Teaching experience in the social sciences has remained about the same, but the proportion in the humanities has shrunk by more than 25 percent and that in mathematics and the natural sciences by nearly 15 percent. On the other hand, presidents with predominant professional interests outside the usual academic fields, as indicated by their teaching, increased by more than 37 percent. Those interests represented professions as varied as engineering, education, mining, agriculture, law, business administration, and military science. Those with a teaching background in business administration increased from 0.0 to 5.1 percent; in law, from 0.0 to 7.7 percent; in education, from 8.1 to 20.8 percent.

The simplest generalization that can be made seems to be that state-supported universities in 1941 were being headed by men whose backgrounds contained more practical administrative and business experience and training than the backgrounds of presidents in 1916. Far fewer professors were called to presidencies because of their scholarly reputations. The three predominant professional fields outside the usual academic departments of the university from which presidents were being recruited in 1941 were law, business, and education. The social sciences are, of course, most closely related to these subjects. Mathematics, the natural sciences, and especially the humanities are apparently no longer regarded as contributing essential or important backgrounds.

It is not difficult, of course, to point out at least one factor that has led to emphasis

upon administrative ability. Comparison of reports from the United States Office of Education for the years 1916 and 1938 shows that the enrollment of the 47 institutions here under consideration increased from 94,600 to 258,900; the numbers of their faculties from 8,600 to 25,200; the value of their property from $111,000,000 to $448,000,000. It was the period of the "great rush" into secondary and higher education. State universities became huge institutions. No state government could overlook so powerful an agency within its borders, especially when legislatures were confronted by calls for appropriations which demanded close scrutiny. Legislators think in terms of business. They expect institutional heads to talk in those terms. Conversely, from within the institution and from its alumni came demands for leadership which, first of all, could obtain adequate financial support.

Manifestly the phases of the work of the state university president which now loom largest before the American public are practical and political. Whether men of these qualities can combine with them the educational and scholarly vision essential to the fulfillment of American destiny through coming generations as conceived one hundred fifty years ago "doth not yet appear."

CURRENT LIST OF MEMBERS OF THE NATIONAL ASSOCIATION OF STATE UNIVERSITIES, WITH NAMES OF PRESIDENTS

Institution	President 1943–44
University of Alabama	Raymond R. Paty
University of Arizona	Alfred Atkinson
University of Arkansas	Arthur M. Harding
University of California	Robert G. Sproul
University of Colorado	R. G. Gustavson, acting
University of Connecticut	Albert N. Jorgensen
University of Delaware	Walter Hullihen
University of Florida	John J. Tigert
University of Georgia	Harmon W. Caldwell
University of Hawaii	Gregg M. Sinclair
University of Idaho	Harrison C. Dale
University of Illinois	Arthur C. Willard
Indiana University	Herman B. Wells
State University of Iowa	Virgil M. Hancher
University of Kansas	Deane W. Malott
University of Kentucky	Herman L. Donovan
Louisiana State University	Campbell B. Hodges
University of Maine	Arthur A. Hauck
University of Maryland	Harry Clifton Byrd
University of Michigan	Alexander G. Ruthven
University of Minnesota	Walter C. Coffey
University of Mississippi	Alfred Hume, acting
University of Missouri	F. A. Middlebush
Montana State University	C. W. Leaphart, acting
University of Nebraska	Chauncey S. Boucher
University of Nevada	John O. Moseley
University of New Hampshire	Position to be filled
Rutgers University (N. J.)	Robert C. Clothier
University of New Mexico	James F. Zimmerman
Cornell University (N. Y.)	Edmund E. Day
University of North Carolina	Frank P. Graham
University of North Dakota	John C. West
Miami University (Ohio)	Alfred H. Upham
The Ohio State University	Howard L. Bevis
Ohio University	W. S. Gamertsfelder
University of Oklahoma	Position to be filled
University of Oregon	Position to be filled
Pennsylvania State College	Ralph D. Hetzel
University of the Philippines	Position to be filled
University of Puerto Rico	Jaime Benítez
University of South Carolina	J. R. McKissick
University of South Dakota	Ila Delbert Weeks
University of Tennessee	James D. Hoskins
University of Texas	Homer P. Rainey
University of Utah	LeRoy E. Cowles
University of Virginia	John L. Newcomb
University of Washington	Lee Paul Sieg
West Virginia University	Charles E. Lawall
University of Wisconsin	Clarence A. Dykstra
University of Wyoming	James L. Morrill

BIRDS PICKABACK

By W. L. McATEE

Most birds seem too wary to be riders and too touchy to be ridden, yet some birds do indulge a good deal in pickaback. The evidence that they do so varies from fact to folklore. The visitor to a zoological garden may from time to time see a number of the animals involved, some of them strange associates for birds. Particularly strong is this impression with respect to the treacherous crocodile and the formidable rhinoceros, but each has a bird attendant so characteristic that it bears its giant companion's name.

The crocodile-bird, the so-called Egyptian plover, is a courser that alights on crocodiles to find and devour their parasites and even enters their mouths to catch flies. Ordinarily, creatures that go into crocodiles' mouths do so involuntarily and never return, but the crocodile-bird, as an exception, is living proof that the crocodiles recognize it and appreciate its services. White egrets also are credited with a sort of valet relationship with crocodiles, as are sun-bitterns with American tapirs.

So burly and irascible are rhinoceroses that they would seem anything but attractive consorts for birds. However, two kinds of African birds allied to the starlings settle on the backs of these dinosaur-like monsters to remove bots and ticks. Rendering the same sanitation for camels and cattle, these birds are also called ox-peckers. Alfred Newton says, "Though the animals are at first alarmed at the visitation, they soon get over the fright, regarding . . . with evident pleasure the way in which the birds creep about them and rid them of the pests." Herbert Friedmann informs me that the ox-peckers also alight on bustards and ostriches. Whether the purpose is the same as when they perch on the large mammals is a question, but the fact is of interest as an illustration of bird riding upon bird—the particular form of pickaback that is the main subject of this essay.

Elephants, though larger than rhinoceroses, are not as irritable and are thus perhaps more attractive to bird attendants. W. P. Pycraft states that egrets in Africa swarm over the bodies of elephants and catch insects put up by the animals. In the New World sun bitterns similarly associate with tapirs. Becoming accustomed to riding upon wild creatures, it was an easy transition to pickaback on the easy-going and patient, domesticated livestock. From this habit, certain white herons are known as cattle egrets. Their natural hosts are the redoubtable water buffalos which, though dangerous when aroused, have been reduced through long breeding and training to manageable strains useful to man. Egrets and other small herons seem to have a tendency almost everywhere to associate with cattle and other stock, upon which they sometimes perch. In this country, Herbert L. Stoddard reports a few instances of seeing snowy egrets, and one of a little blue heron, on the backs of hogs. He has also seen an egret of this same species on a cow.

The birds that frequent domestic stock do so for two principal reasons: to search the bodies of the animals for edible parasites, and to glean insects attracted to the stock or flushed by its trampling or grazing. Certain groups of birds have evident predilections for these specialized modes of feeding. The mynas, starlings, and their allies, and the anis, and cowbirds and blackbirds quite characteristically feed on and about cattle; the shrike-like drongos of Asia (according to H. G. Deignan) and certain flycatchers come to cattle for flies or even use them as vantage posts from which to swoop upon insects stirred up by the animals. This association was recognized in the design of an archaic Greek coin which showed a cow with a bird on its back. There has been some dispute among classicists as to the identity of the bird, but if an ornithologist were asked to name it on the basis of greatest probability, he would say the starling.

In Africa a starling (*Sturnopastor*) and in North America the cowbirds (*Molothrus*) have won the name buffalo bird from their association with the water buffalo and the

bison, respectively. Edwin James, botanist on Long's Expedition of 1819–20, notes that the bisons "from their submission to the pressure of numbers [of these birds] . . . seem to appreciate the services they render, by scratching and divesting them of vermin."

Cowbirds, writes E. T. Seton, "haunt the buffalo as negroes do a Mississippi raft-house; sometimes on it, sometimes on the nearest land, but always moving when it moves, and recognizing it as headquarters." He notes an instance of a cowbird surviving the winter at Winnipeg, Canada, by warming itself on a bison's back by day and sleeping in a hollow it had snuggled in the animal's hair. An Indian myth asserts that the cowbird nests in the wool between the horns of the buffalo. Unfortunately for this story, the cowbird does not nest at all, foisting its eggs for hatching upon a variety of foster parents. A number of early explorers of the west reported cowbirds, or prairie blackbirds as they called them, as alighting not only upon buffalos but also on horses and mules and even on men. Lewis and Clark of the famous expedition sponsored by Thomas Jefferson called the cowbirds buffalo peckers. In more recent times they have taken in the same way to sheep and hogs, and Herbert Friedmann has seen them perch upon elands, yaks, and emus in zoos.

Cowbirds are of the blackbird alliance, and their kin, Brewer's blackbird, a western species, has been recorded as a pickaback upon sheep. The writer has seen boat-tailed grackles, of the same family, swarming about cattle in Louisiana, jumping up from the ground to snap ticks or flies from the animals' bellies and clambering all over them, even climbing up and down their tails. By measurement these birds are about the same size as fish crows, although proportionally more is allotted to tail, and it seems remarkable that the cattle should tolerate such intimate attentions from them.

Anis represent another group of birds—the cuckoo tribe—among the perchers on cattle. Their purpose in visiting the animals is so obvious that it has earned for them the name of tickbirds and what amounts to the same thing in Spanish, *garrapateros*.

Among the flycatchers, the common phoebe of the eastern United States, according to an observation of the writer, under certain circumstances will pick insects from a domestic animal. Years ago at the Santee Club, South Carolina, on a drizzly, winter morning when insects doubtless were all but banished from the air by the cold and rain, a phoebe was seen hovering about a cow and at times clinging to her hair while it snapped up the insects attracted by the shelter and warmth of the animal's body.

The short-winged tyrant flycatchers of Argentina have more than once been recorded as attending cattle. W. H. Hudson wrote of them in 1888, "They haunt the cattle-pens, and become extremely familiar with the cows, horses, and sheep, following them to the pasture grounds, where they are often seen perched on the back of a horse or other domestic animal, or stationed close to its nose on the ground, watching for insects." The fire-crowned tyrant of Brazil is an associate of the marsh deer upon which it is known to alight.

The perching of birds upon animals is not altogether an innocent and mutually advantageous arrangement; like so many relations, it has become perverted in some instances and has a sinister side. The case of the kea is well known; this New Zealand parrot goes on from eating carrion of sheep to digging through the wool and flesh of the living animals to get the kidney fat. In our Western States, magpies begin by picking warbles from the hides of cattle and continue by tearing away adjacent tissues; they also take advantage of other wounds; and in both ways sometimes do enough damage to cause death of their victims. Recently under stress of winter weather that made food hard to find, starlings in flocks have imitated the magpies and incurred the wrath of the stockmen.

A few instances have been mentioned of birds alighting on other birds and these are guides to the heart of our subject of bird pickaback. Naturally, large kinds are the bearers and smaller ones the riders. As noted, ostriches and bustards are sought by the ox-peckers. Ostrich stature need not be particularized, but it may be well to state that bustards are of the size of our wild turkey or somewhat smaller. One of them,

the crested bustard of East Africa, according to W. P. Pycraft, is habitually perched upon by the rosy bee-eater as a watch post from which to capture insects. An interesting account of pickabacking, involving storks and flycatchers, may well be quoted from the famous explorer Samuel W. Baker. Near the Blue Nile in Abyssinia, he writes:

> During the march over a portion of the country that had been cleared by burning, we met a remarkably curious hunting-party. A number of the common black and white stork were hunting for grasshoppers and other insects, while mounted upon the back of each stork was a large copper-colored flycatcher, perched like a rider on his horse, keeping a bright look-out for insects, which from its elevated position it could easily discover. . . . I watched them for some time; whenever the storks perceived a grasshopper or other winged insect, they chased them on foot, but if they missed their game, the flycatchers darted from their backs and flew after the insects like falcons, catching them in their beaks, and then returning to their steeds to look for another opportunity.

Some birds should be accustomed to pickaback, as they begin young. Who has not seen domestic chicks, or peepies, climbing about or resting upon a reclining hen? When she gets up and begins to walk, however, they cannot stick but despite every effort slide off, breaking the fall by flapping their little wings. The same chick behavior is seen in related birds, as the bobwhite and ruffed grouse, and may be generally characteristic of the grouse-quail-partridge alliance. The young of certain water birds succeed better as jockeys, riding their parents who can swim so much better and faster than they. Birds manifesting this habit are the grebes, loons, and swans. In 1672, Nicolas Denys wrote that great auks carry the young on their backs and take them as far as the Bank—presumably the Great Bank off Newfoundland.

It seems possible that parental aid may be in some instances extended to young that are well grown. One further step would result in similar collaboration among adults. There are apparent illustrations of both of these traits. As to the first, George H. Mackay, a New England sportsman of the highest veracity, wrote in the leading American ornithological magazine on the "Behavior of a Sandhill Crane":

> While shooting near Madelia, Minnesota, one autumn day some years ago (Oct. 1 or 2, 1873), my companion, Mr. Horace Thompson of St. Paul, slightly wounded with a rifle ball at long range an immature Sandhill Crane (*Grus mexicana*) which with several others was resting on the prairie. At the report they all flew away except the wounded bird and one other which apparently was its parent. The wounded bird, after a number of unsuccessful attempts to fly (assisting itself by first running, accompanied by the parent which kept beside it), finally succeeded in rising some ten or fifteen feet from the ground, but it evidently could not long sustain itself in the air. The parent bird, perceiving this, deliberately placed itself *underneath* the wounded one, allowing it to rest its feet on her back, both birds flapping away all the while. In this position she actually succeeded in bearing it off before our eyes for quite a distance to a place of safety, where we would not follow it. It was one of the most touching examples of parental affection in a bird that has ever come under my observation.

The other illustration, attributable to no individual, and not as clear cut, may be worth citing from the authority of *Forest and Stream* in which it appeared. It alleges assistance in flight to a wounded member of a flock of Canada geese.

It is undeniable that the young of certain birds ride their parents and that some adult birds habitually perch upon stationary or even slowly moving animals, including larger members of their own order. The question remains whether any birds are carried by their fellows in full flight. Folklore says they are; science does not know.

According to Ernest Ingersoll, "The Arawak Indians of Venezuela relate that their ancestors obtained their first tobacco plants from Trinidad by sending a hummingbird, mounted on a crane, to snatch and bring back the jealously guarded seeds."

The European quails, smaller than ours but with similar short, cuppy wings adapted to swift bursts of flight but apparently not to protracted migration, nevertheless cross the Mediterranean Sea. Unable to believe that they do so under their own power, people conceived the idea that they make the journey as passengers upon cranes. Pierre Belon mentioned this belief in 1555, but it is much older, in fact it is traditional. The Tartars of Siberia believed that corn-crakes were carried southward by cranes.

Henry J. Van-Lennep refers to small bird travel by cranesback in his book *Bible Lands* (1875) but writes as one assuming, rather than proving, the fact. He says, in part:

> We have often been struck with the great number of birds, particularly of the smaller species, which inhabit Western Asia, as compared with Europe and North America. We have so often made this observation upon the three continents, that it seems to be a fact settled beyond a doubt. The most natural explanation of this circumstance lies in the fact that the feathered tribe, even those of feeblest wing, have an easy road from Palestine, Syria, and Mesopotamia, by the Isthmus of Suez, and over the narrow Red Sea, to their winter-quarters in tropical Africa, while nature has provided them with extraordinary means of conveyance from Asia Minor southward across the Mediterranean, which will presently be described. . . . He who is ever mindful of the smallest of his creatures has provided them with means of transportation to a more genial clime. Many of them, indeed, find their way downward from Palestine into Arabia and Egypt, but this would be difficult, if not impossible, where lofty mountains and broad seas intervene; and to meet such cases the crane has been provided. . . . In the autumn, numerous flocks may be seen coming from the north with the first cold blasts from that quarter, flying low, and uttering a peculiar cry as if of alarm, as they circle over the cultivated plains. Little birds of every species may then be seen flying up to them, while the twittering songs of those already comfortably settled upon their backs may be distinctly heard. On their return in the spring, they fly high, apparently considering that their little passengers can easily find their way down to the earth.

It is not clear whether this author means that he has personally seen the phenomenon described; another writer implies that he has, but he remains unidentified. In a letter published in the *New York Evening Post*, November 20, 1880, a correspondent using the pseudonym, "Phone," writes of "The singular methods of travel the wagtail adopts to cross the Mediterranean Sea." He says, "In the autumn of 1878, on the Island of Crete, the village priest called my attention to the twittering and singing of small birds distinctly heard when a flock of cranes passed on their southward journey. Upon discharge of a gun, three small birds were seen to rise from the flock and soon disappeared among the cranes."

If "Phone" had been George Newbold Lawrence, an eminent New York ornithologist of the period, or were otherwise identified as an accurate and credible observer, we should perforce believe that there is something in the crane ferrying services. As it is, we can only conclude, "interesting if true."

References, the originals of which have not thus far been seen by me, quote a German author as saying it is "believed at Cairo that wagtails and other small birds cross from Europe to Nubia and Abyssinia on the backs of storks and cranes," and a Swedish traveler as stating that on the Island of Rhodes "where the storks came in flocks over the sea . . . he often heard the notes of small birds, without being able to see them; but on one occasion he observed a party of storks just as they alighted, and saw several small birds come off their backs."

As reported in North America on the basis of Indian belief, a supposed instance of crane-assisted migration has various points of dubiety. It was recorded by J. C. Merrill, an accomplished and reputable bird student, but only upon hearsay. There is a general belief among the Crow Indians of Montana, he notes, that a bird, apparently a grebe, which they call the cranesback, arrives and departs with the sandhill crane. "About ten or fifteen per cent. of cranes are accompanied by the 'crane's back,' which, as the crane rises from the ground flutters up and settles on the back between the wings, remaining there until the crane alights." The Cree Indians have a similar story involving the white or whooping crane.

In comment, it must be said that grebes are birds of rather substantial size, and a pound or more in weight, which can by no means nestle among the feathers of cranes, and that their feet are very ill-adapted to clinging to anything. The Indian legend refers to "a constant chattering whistle" made by the alleged crane riders and grebes have no such note.

Ernest Ingersoll again contributed an interesting item to the record, saying:

> Mr. E. Hagland, of Therien, Alberta, wrote to me as follows in a casual way, without any prompting, in April, 1919: "One fall a flock of cranes passed over me flying very low, and apart from their squawking, I could distinctly hear the twittering of small birds, sparrows of some kind. The chirping grew louder as the cranes drew towards me, and grew fainter as they drew away; and as the cranes were the only birds in sight I concluded that little birds were taking a free ride to the south."

In writing of the Canada goose, John Rae, the well-known explorer, states:

> The Cree Indians at both these places [Moose and York Factories], assert positively that a small brown

bird uses this goose as a convenient means of transport to the north, and that they have been often seen flying off when their aerial conveyance was either shot or shot at. The little passenger has been pointed out to me, but I have forgotten its name. Certainly it makes its appearance at the same time these geese do, which, by the way, are the only kind that are said to carry passengers. The natives of the Mackenzie River, more than a 1000 miles to the north-west, tell the same story, so I believe in its truth.

In a separate statement Rae says, "An intelligent, truthful, and educated Indian named George Rivers, who was frequently my shooting companion for some years, assured me that he had witnessed this, and I believe I once saw it occur."

John Richardson sharpens the details of this story but does not, like Rae, affirm that he accepts it. His account is:

The Indians believe that a small finch [the Lapland longspur] (*Plectrophanes lapponica*) avails itself of the strength of wing of the Hutchin's goose, and nestles among its feathers during its flight. When a goose is shot, they often see the small bird flying from it. Neither Mr. Rae nor I noticed such an occurrence, nor did I obtain a confirmation of it from the personal observation of any of the gentlemen resident in the country, but it is generally affirmed by the Indians.

A related item involving Maine Indians is given by A. F. Gilmore in a book published in 1919:

The old Penobscot Indian who sometimes acts in the capacity of guide on my excursions into the north woods assures me that his tribe believe that all the 'little chip birds' make the long migrating journey by clinging to the backs of the larger birds, strong fliers as Loons, Geese, Ducks, Herons, etc., stealing a ride as it were.

What is perhaps only an example of "newspaper science," from a St. Louis journal in November 1936, alleges that a hummingbird was found nestled in the feathers of a Canada goose shot at Williams Lake, British Columbia.

European geese are mentioned as migration aiders in one rather roundabout record. A correspondent of the *London Field* gives his recollection of an article in the *Newcastle Weekly Chronicle* to the effect that an English ship's captain saw in the Strait of Gibraltar a flock of geese passing from the African to the European coast. With the glass, small birds about the size of larks were seen to rise from the backs of the geese and to return. The observation is said to have been verified by several people.

Now for a most circumstantial account of avian pickaback, involving a smaller bearer than any previously mentioned. T. H. Nelson, the correspondent just referred to, had it from a Mr. Wilson, foreman on the South Gare Breakwater at the mouth of the Tees River, England. Wilson said:

I was at the end of the Gare on the morning of the 16th of October [1879] and saw a "Woodcock Owl" [short-eared owl] come flopping across the sea. As it got nearer I saw something sitting between its shoulders, and wondered what it could be. The Owl came and lit on the gearing within ten yards of where I was standing, and, directly it came down, a little bird dropped off its back and flew along the river. . . . We followed the little bird and caught it.

Nelson was shown the specimen, which was a golden-crested wren or kinglet, and he says, "I have every reason to believe that what I have written is correct."

Are we, as distant reviewers, to believe these tales or to reject them? "Where there is so much smoke, there must be some fire," goes the adage, and we may well heed it in judging the evidence presented as to birds riding upon birds. Knowing that tired migrants alight upon moving vessels, we should not doubt too strongly that they sometimes avail themselves of transport by large birds. Admitting that this pickaback phenomenon actually occurs, we need not grant, however, that it is an important factor in bird migration. For one reason, small birds always outnumber the large and could by no means find accommodation on their backs. For instance, the longspur riders of one of the American tales number thousands to the hundreds of their supposed steeds, the Canada geese, and some such disproportion of numbers prevails in every case. Manifestly pickabacking cannot be a major factor in migration. Yet as to its simple occurrence, there can hardly be disbelief.

Legendry is even more hospitable to strange beliefs than are younger stages of folklore, hence we are not surprised to learn that the very widespread European tradition of the sovereignty of the wren over all birds has a pickaback basis.

The following version is taken from Thompson's "Birds of Ireland." . . . In a grand assembly of

all the birds of the air, it was determined that the sovereignty of the feathered tribe should be conferred upon the one who should fly highest. The favorite in the betting was of course the eagle, who at once, and in full confidence of victory, commenced his flight towards the sun: when he had vastly distanced all competitors, he proclaimed with a mighty voice his monarchy over all things that had wings. Suddenly, however, the wren, who had secreted himself under the feathers of the eagle's crest, . . . popped from his hiding-place, flew a few inches upwards, and chirped out as loudly as he could, "Birds, look up and behold your king!"

A German version substitutes the stork as carrier.

Algonquin Indians of America had a similar myth relating to a linnet and eagle but it had a more practical ending. In a test as to which bird could fly highest, the eagle flew as high as it could "when the gray linnet, a very small bird, flew from the eagle's back, where it had perched unperceived, and being fresh and unexhausted, succeeded in going the highest." However, the eagle was given the prize because it had carried the linnet on its back.

In the Western Hemisphere, we have various birds which temporarily ride other birds. Hummingbirds of a variety of species do this in defense of their nesting territories. The Argentine chope, a blackbird closely related to the boat-tailed grackle previously mentioned, according to W. H. Hudson, fights off predatory birds even as large as the caracara eagle, "pouncing down and fastening itself on the victim's back, where it holds its place till the obnoxious bird has left its territory."

The legends previously referred to concerned stratagems to obtain recognition as king of birds, but in America we have in real life a pickaback bird which at every opportunity asserts its right to the title "king." This is the well known bee-martin, or kingbird, which attacks other birds regardless of size. Crows, hawks, vultures, and eagles, look alike to him. Either because of his smaller size and adroitness or because he really bluffs them, he seldom meets resistance. Screaming malediction and defiance, he pecks at them, pulls their feathers, and literally rides them off the field of battle.

THE CRANE'S BACK

I notice that in the *Forest and Stream* of Dec. 23 you reprint a letter published in the *Evening Post* on the subject of wagtails crossing the Mediterranean Sea on the backs of cranes and storks. This has the indorsement of the eminent ornithologist von Heuglin, and induces me to report a general belief among the Crow Indians of Montana that the sandhill crane performs the same office for a bird they call *napite-shu-utle* or "the crane's back." This bird I have not yet seen, but from the description it is probably a small grebe. It is "big medicine," and when obtained is rudely stuffed and carefully preserved. I hope to have one brought to me soon for identification . . . . many of their hunters and chiefs have assured me that they have frequently seen the birds carried off in this way. At these times the bird is said to keep up a constant chattering whistle, which is the origin of the Crow custom of warriors going into battle each with a small bone whistle in his mouth; this is continually blown, imitating the note of the crane's back, and, as they believe, preserves their ponies and themselves from wounds, so that in case of defeat they may be safely carried away as is the *napite-shu-utle*. The Cree Indians are said to observe the same habit in the white crane.—J. C. MERRILL, *Forest and Stream*, March 10, 1881, p. 105.

THE BRAZILIAN RACIAL SITUATION

By DONALD PIERSON

PROBABLY the most significant and far reaching event of the past five hundred years has been the expansion of western Europe. Its ecological, economic, political, and cultural consequences have extensively modified human living throughout virtually the entire world and, incidentally, have presented us with most of our present social and cultural problems.

Although the general character of the expansion of western Europe is familiar, it may be useful to recall here some of the more important incidents connected with it. For instance, extensive explorations and discoveries from the fifteenth to the present century have made known to large numbers of Europeans even the most inaccessible outlying regions. Invasion and conquest, the establishment of mandates and protectorates, the demanding and obtaining of extraterritorial rights had at the outbreak of the present war brought under European political control 84 percent of the world's surface and 69 percent of its peoples. Moreover, in the course of this expansion, widespread dispersions of population have occurred. Large numbers of Europeans left their homes and migrated to other lands, especially to the New World, but also to Australia, to New Zealand, to South and North Africa, and to other areas. At the present time it is estimated that there are approximately 160 million people of European origin living outside Europe.

As one of the consequences of the several attempts of these European peoples to root themselves in new habitats, an extensive slave trade developed which, combing the coasts and interior regions of Africa for approximately four centuries, transported millions of Africans into the United States, the West Indies, and Brazil. And, following the abolition of slavery throughout the British Empire in 1833 and, by 1865, in nearly all parts of the world, the development of a contract labor system had as one of its results the migration of hundreds of thousands of Chinese and natives of India into South and East Africa (especially into the Transvaal and Natal), into Siam, Malaya, the Dutch East Indies, Burma, Ceylon, and the West Indies. Thousands of other Asiatics subsequently left Asia for the islands of the South Seas, the Americas, and other regions. At the present time, between 16 and 17 million people of Asiatic origin are estimated to be living outside Asia. Of East Indians alone 4,125,000 have migrated beyond the borders of India. They now compose two-thirds of the population of Mauritius, or approximately 150,000; one-half of the population of British Guiana, or approximately 145,000; one-third of the population of Trinidad, or approximately 140,000. In some cases, they are supplanting the natives. For instance, in the Fiji Islands, the East Indians in 1921 numbered 60,000, while the Fijians numbered 84,000. In the subsequent sixteen years, the East Indians increased approximately 29,000, while the Fijians increased only about one-half of this number.

Also incidental to the expansion of Western Europe was the diffusion of European culture over large areas of the world's surface until its often subtle influences have penetrated, to a greater or lesser extent, even the more isolated and remote regions. European artifacts are now commonly found all over the world; for example, the Standard Oil can (because of its manifold uses, a prized possession of many present-day feudal and folk peoples), European rifles, cannon, war-ships, airplanes, automobiles, tractors, cameras, electric lights, cigarettes, rubber goods, and chemicals. European languages are now spoken by millions of people outside Europe. European clothing has, to a greater or lesser extent, supplanted native garb throughout North and South America, the West Indies, Japan, Hawaii, the Philippines, Australia, New Zealand, Turkey, Egypt, India, China, and South Africa. European religions have now crowded out, or are in serious competition with, the native religions of the Americas, Africa, Australia, New Zealand, the South Sea Islands, China, and

India. European ideas, attitudes, sentiments, points of view, and philosophies of life have been widely diffused by such human agencies as missionaries, traders, soldiers, sailors, colonial administrators, scientists, and tourists; by indirect means, like radio broadcasts, newspapers, magazines, and books; as well as by those native men and women who, subsequent to a period of study in Europe, have returned to their native lands to become powerful centers of European diffusion.

But probably the most significant of all the events connected with the expansion of western Europe, at least so far as its actual contribution to this expansion is concerned, has been the development of a world-wide economic order. This world-wide economic order, based upon European manufactures and the persistent exploitation of natural resources in all parts of the world in order to provide the necessary raw materials, has involved the operations of a vast commercial fleet to carry raw materials to Europe and to distribute, in turn, European articles of manufacture over all the outlying areas.

The export from Europe of capital and machinery marked the final phase of the entire expansion process. It marked the final phase because this export of capital and machinery resulted in the development of manufacturing centers in outlying areas, particularly in India, China, South Africa, South America, and in other places where local production is now coming seriously into competition with European manufactures. This increasing competition for local markets has been intensified in recent years by the counterexpansion of Japan, whose people, accepting those elements of European culture which were advantageous to them and discarding all else, seriously entered the markets of the world, at an enormous disadvantage to Europe. All this has led to increasingly severe competition between European nations for constantly shrinking markets, and has contributed in no small way to declining profits, to "frozen" credits, financial crises, depressions, and wars.

Since this competition, in all likelihood, will not grow less in the future but, on the contrary, will probably increase, European economic domination of the world is now apparently at, or near, an end. European ecological expansion began to diminish early in the present century, and the settlement abroad of great numbers of Europeans practically ceased two decades ago. The political domination of Europe also appears to be suffering serious strain with the rise of nationalism all along the line of European advance—in India, Egypt, Turkey, Morocco, China, and South Africa. Even if Germany, with her recent remarkable military development, should be able to reshuffle European political control, it is doubtful if she could long stem the rising tide of nationalism, particularly in Asia, any more effectively than could Great Britain, France, or any other imperial power. Only the cultural expansion of Europe, proceeding as it does by more subtle means, appears to be likely to continue indefinitely in the future.

I have sketched the expansion of Europe in some detail in order to suggest a fruitful frame of reference for the study of the contact of races in the New World. The expansion of Europe is a distinct historical process. It constitutes an era of world history which had a definite beginning and which, as careful observers of the present scene are pointing out, is now at, or near, an end. It has, therefore, a unitary character which makes it a *thing* like any other natural object and consequently subject not only to study in terms of itself but also to comparison with other instances of the same type; subject to comparison, for example, with the Greek and Roman expansions in the ancient world, with the so-called "barbarian" invasions of the Roman Empire, the Arab migrations across north Africa and into the Iberian peninsula, and the Mohammedan expansion into northern India.

Not only is the expansion of Europe, as a unit, comparable to other cases of expansion, but the varying circumstances and conditions under which it proceeded in different parts of the world and at different periods of time, together with the varying series of consequences thus elicited, are themselves capable of comparison and, hence, of yielding a body of general data.

The coming together in Brazil of Europeans and native Indians and the subsequent importation of Africans were incidents of

this expansion, as similarly was the coming into contact of Europeans and native Indians in the United States and the subsequent importation of large numbers of Africans into that country. Since the cultural consequences of these contacts differed, as well as the conditions and circumstances under which they took place, a detailed study of these variations may conceivably throw significant light upon the precise nature of the cultural processes involved and upon the ways in which, under given circumstances, they operate.

One incident extensively connected with the expansion of Europe was the development of a plantation system in several different regions of exploitation. For instance, in recent years, huge rubber plantations have appeared in Sumatra, the Malay peninsula, East and West Africa, and in regions of the New World. During the 16th, 17th, and 18th centuries, sugar plantations flourished on several islands of the West Indies. During the 17th, 18th, and the first half of the 19th centuries, in particular, huge cotton and tobacco plantations dotted the southern parts of the United States. During the 16th and 17th centuries there developed in Brazil, particularly at Bahia and Pernambuco, one of the world's first great centers of sugar cane production, where a planter aristocracy grew rich furnishing sugar for the tables of Europe. This commerce eventually became so extensive that sugar, which previous to its cultivation in Brazil had been rare in Europe, became a common article of European commerce. In 1800, an English smuggler, Thomas Lindley, imprisoned at Bahia, looked out over the shipping in the harbor, and wrote, "a degree of wealth, unknown in Europe."

The development of these 16th, 17th, 18th, and 19th century plantations in Brazil, the West Indies, and the United States created an ever-increasing demand for cheap labor and eventually led to the importation of African slaves on a huge scale. It is estimated that from 1680 to 1786, 2,130,000 Africans were brought into the West Indies and the United States. Hispaniola alone is said to have received 1,000,000 during the entire slave period. Since, following emancipation in 1888, all official records of the Brazilian slave trade were destroyed, the number of Africans imported into this part of the New World probably never will be known with any exactitude but it was, in all probability, greater than the number imported into either the West Indies or the United States. Although the slave trade was presumably abolished in Brazil in 1831, it is estimated that during the quarter century from 1825 to 1850, 1,350,000 Africans were disembarked in her ports.

The subsequent careers of these imported Africans varied with place and with the circumstances and conditions of contact and subsequent racial experience. It is for this reason that the exhaustive study of the circumstances and conditions surrounding each case of contact, and the subsequent comparison and contrast of cases, conceivably may throw significant light upon the problems, practical as well as theoretical, growing out of race contact, problems which, with increasing speed of communication and the consequent shrinking of the earth's surface, are coming each year to be more and more acute. As an important part of this extensive study, we may set down here the more significant facts regarding the career of the African in Brazil. Unfortunately, it is possible to cite here only the general outline of this career. Those who are interested in the detailed investigation upon which these generalizations are based will find considerable information in the writer's book, *Negroes in Brazil. A Study of Race Contact at Bahia,* (University of Chicago Press, 1942).

Of particular significance is the fact that, although probably more Africans were imported into Brazil than into any other region of the New World, the Negro, like the Brazilian Indian before him, is apparently disappearing as a racial unit. The general tendency throughout Brazilian history seems to have been to absorb, gradually but inevitably, all ethnic minorities into the predominately European stock.

It is true that the mixed-bloods are increasing, but their increase appears to be at the expense of the African and not of the European. Nor is there growing up in Brazil a relatively permanent mixed racial stock, like the Macanese in China, the Goanese in India, or the "Cape Coloured" in South Africa.

Instead, the mixed-bloods appear to be gradually absorbing the blacks, while they themselves are increasingly being incorporated into the predominately European stock.

In the development of this general tendency to amalgamate and to assimilate all ethnic minorities, the circumstances and conditions of colonial settlement played a significant role. In Brazil, unlike the United States, few European women emigrated during the first years of colonization. Until stable living conditions and a normal distribution of the sexes were achieved, the cohabitation of Portuguese men with native Indian women commonly took place. In this way there was assured a population large enough to colonize successfully the new frontier, in spite of the fact that the mother country, Portugal, was unable to provide it by reason of the drain upon her slender population resources to conquer and to maintain the Empire in Africa and the East Indies. When Thomé de Souza, in 1549, established the first permanent settlement at Bahia, he found on and about the Bay of All Saints on which the city was built a large number of mixed-blood descendants of Portuguese sailors and adventurers who for some years had been living with the Indians. Many of Thomé de Souza's men took mates from among these mixed-bloods; others cohabited with pure Indian women. These interracial unions, as in Goa and elsewhere throughout the Portuguese dominions in the East, were subsequently encouraged as a matter of policy by the Portuguese state, and the Catholic Church, as Gilberto Freyre in *Casa grande e senzala* puts it, "regularized them into Christian marriage," thereby lending religious sanction to interracial crossing and bringing parents and children within the control and discipline of the Church. Thus, there gradually grew up and became firmly fixed in the mores of colonial Brazil a tradition of intermarriage.

This case of racial intermarriage during the precarious days of settlement is not unique in the history of European expansion. In fact, in those instances in which the sex ratio was out of balance, it seems to have been universal. The settlement of the United States, at least in large part, was not one of these cases. But the settlement of South Africa by the Dutch, and of India by the English, were accomplished under similar circumstances. In both of these cases, the mixed-bloods were at first accorded the treatment and the career usually accorded the progeny of fathers whose normal parental sentiments do not run counter to caste sentiments laid down in the mores. On this frontier, as on all frontiers, a new society was emerging, and the mores which grew up and crystallized into fixed and relatively permanent customs were the result of the unwitting and unplanned responses of human beings to the needs of their time and place.

Miscegenation, particularly when linked with intermarriage, resulted in bonds of sentiment between parents and offspring which hindered the arising of attitudes of race prejudice and at the same time placed the mixed-bloods in a favorable position for social advancement. With rise in class, intermarriage between whites and mixed-bloods, especially those of the lighter shades, became increasingly common.

Thus, endogamy has for some time been breaking down in Brazil, particularly along the biological borders of the races and, with the continued rise of individuals from the inferior status group, this tendency is evidently increasing. It is true that color and negroid features are still symbolic of slave origin, and that these racial marks still tend to be closely identified with low status, and to constitute for this reason an obstacle to marriage into the upper classes. But these symbols tend to lose their restraining character not only in proportion to the degree white intermixture increases, but also, and more importantly, in proportion to the degree their traditional meaning is called into question, in the case of a given individual, by evidences of other qualities associated with status in the upper levels of society.

One should point out in this connection that, in general, slavery in Brazil, as also to a considerable extent in the United States, was characterized by the development of increasingly intimate primary relations between master and slave, and that the resultant personal attachments inevitably tended to humanize the institution of slavery and to undermine its formal character. Thus, Brazilian slave society became organized, to

a considerable extent, on a familial and personal basis. The custom of manumission became firmly intrenched in the mores, constituting, at least under certain circumstances, universally expected behavior. Brazilian Negroes were thus released from a servile status *gradually* and under circumstances which favored the continuance of intimate personal ties already built up.

Moreover, emancipation sentiment in Brazil never suffered from a wave of fear like that which swept over our South after the Negro uprising in Haiti and the disorders attendant on the subsequent annihilation of the Haitian whites. Neither was it limited to any one section of Brazil, but on the contrary penetrated every community. Even in Bahia, where the institution of slavery was apparently very firmly rooted, individuals and organizations possessing prestige in the eyes of the community, and including a considerable portion of the press, took up the slaves' cause. Thus, the "struggle for consistency" in the Brazilian mores between the ideas associated with slavery, on the one hand, and the ideas disseminated by the Church, the French Revolution, and the abolitionists, on the other, went on *inside* each local community where it had in its favor the intimate and personal relations of individuals who not only lived in close proximity to each other but also were bound together by intimate ties of family, religion, and friendship. Final emancipation came about as the culmination of a widespread liberation movement which for years had dominated the public mind. Thus, the release of the last slaves in bondage did not, as in the United States, occur as an incident of civil war; nor was the pattern of race relations which had grown up and taken form during slavery ever submitted to the strain of a social upheaval following a crushing military defeat and the imposition of policies of "reconstruction" from without.

Thus, the Brazilian white has never at any time felt that the black or the mixed-blood offered any serious threat to his own status. No feelings of fear, distrust, apprehension, dread, resentment, or envy, have been stirred up, as in the South during and following the Civil War, no sense of unwarranted aggressions or attacks. It is probably for these reasons that race prejudice, as it is understood in the United States, does not exist in Brazil. For race prejudice appears to be a function of a racial situation in which a dominant race senses, either consciously or unconsciously, a threat to its status.

In general, the present economic status of the Brazilian Negro, at least as I have intimately known him in Bahia, is not greatly dissimilar to that of the North American Negro. Either pure or mixed with the white, the Brazilian Negro is represented to some extent throughout the entire occupational scale. However, as one might expect, considering his original slave status, his relatively disadvantaged position upon receiving his freedom, and the comparatively brief time he has been able to compete on more or less equal terms with the white, the Brazilian Negro is still concentrated in the low-pay, low-status employments.

It is possible that the Brazilian blacks and mixed-bloods, lacking as they do in most cases the profound sense of inferiority which has long been characteristic of the Negro in the United States, particularly of the mixed-bloods, have been less activated by personal ambition and consequently have not perhaps, *as a group,* risen in class as rapidly as has the Negro in the United States. Feeling themselves less under the necessity of demonstrating to a hostile white world their individual talents and abilities, they have not been driven by the same powerful incentive for social advancement.

But it is exceedingly important to note that this rise in class on the part of the Brazilian blacks and mixed-bloods, when it does occur, is recognized not merely inside the Negro world, as is largely the case in the United States, but by *virtually all* members of the Brazilian community.

In Brazil, there is no deliberate segregation as one ordinarily finds where races have been embittered for a long time; residential distribution of the racial elements is largely the consequence of economic sifting. Such isolation as does exist is in large part due to differences in economic and educational level, or to the Negro's identification with African cultural survivals, particularly the fetish cult. For the assimilation of the *Africanos,* particularly in the five principal centers of

Negro concentration—Bahia, Recife, Maranhão, Rio de Janeiro, and the interior of Minas Gerais—while now far advanced, is not yet complete. African cultural elements still persist, particularly the attitudes, sentiments, and ideas associated with religious practices, thus setting apart to some extent a portion of the black population.

Lynching and the rape of white women by colored men are unknown, "passing" is unnecessary, and circumstances are not ordinarily conducive to the appearance of the personality known as the "marginal man."

Since, then, the blacks, the mixed-bloods, and the whites do not constitute endogamous occupational groupings, the social structure in Brazil is not that of caste. Nor does the Negro in Brazil appear to be, as he is in the United States, developing into a highly self-conscious racial minority in free association with, but not accepted by, a dominant racial majority. Instead, the entire organization of society tends to take the form of a freely competitive order in which individuals find their social position on the basis of personal competence, individual achievement, and fortuitous accident, rather than on the basis of racial descent, a fact which is perhaps best reflected in the saying commonly heard at Bahia, "A rich Negro is a white man, and a poor white man is a Negro."

The Brazilian racial situation is, then, sufficiently distinct from those racial situations in many parts of the world where a national or racial minority, like the European Jew, or the North American Negro, for example, is in free association with, but not accepted by, a dominant national or racial majority, and from the racial situation of India, where the social order is entirely organized on the principle of caste, to constitute, along with perhaps the Hawaiian racial situation and certain others, *a distinct type* namely, a multi-racial class society.

Although Brazil seems never to have had a *formal* racial policy, the traditional behavior which grew up under the influence of immediate and unreflecting responses to the conditions and circumstances of colonial life gave rise to an *informal* racial policy, or racial ideology, which underlies and gives consistency to the mores, and appears in active consciousness only when the mores are questioned from without and individuals seek to make reasonable and to defend their customary conduct. This ideology is perhaps best summarized in the phrase commonly heard at Bahia, "We Brazilians are becoming *one* people."

Thus the race problem in Brazil (in so far as there can be said to be a race problem) is in large measure identified with the resistance which an ethnic group offers, or is believed to offer, to eventual absorption into the predominantly European stock.

This does not mean that there are no social distinctions in Brazil. Neither does it mean that there is no discrimination, that whites freely accept Negroes in marriage, or that the Negro's conception of his role is in all cases identical with his status. Prejudice exists in all parts of Brazil. But, with the possible exception of certain areas of the south, where the arrival in comparatively recent years of numbers of immigrant peoples with alien attitudes and sentiments has perhaps modified to some extent the original Brazilian mores, it is *class*, rather than *race*, prejudice. It is the kind of prejudice which one finds *inside* the ranks of the Negro in the United States. The significant fact remains that wherever the original Brazilian mores prevail, a man of color not only may, by reason of individual ability, personal competence, or favorable circumstance, improve his status, but also enjoy recognition of this achievement on the part of white members of the community as well as black.

THE UNITED FRONT

By HARRISON HALE

THE year 1943 marked the bicentennial of the birth of both Antoine Laurent Lavoisier (August 26), Frenchman and Father of Modern Chemistry, and Thomas Jefferson (April 13), author of the American Declaration of Independence. A friend and contemporary of these distinguished men was Pierre Samuel du Pont de Nemours, a Frenchman who later became an American and exerted a lasting influence upon the history and industry of our country. These three, Lavoisier, Jefferson, and du Pont, may be considered as symbols of our science, government, and industry; their cooperation presented a United Front for the advancement of civilization and the welfare of mankind.

As Jefferson was a statesman, vitally interested in science, so Lavoisier was a scientist who gave much of his time and effort to serving his country, only to lose his life by the guillotine during the troublous days of the French revolution. Lavoisier, too, was well-to-do and trained as a lawyer, but was also a scientist. He did not practice law, for he loved science and at the age of twenty-three won a medal for a paper on the best method of lighting the streets of Paris. His accuracy led him to doubt the Theory of Phlogiston, especially since the use of the balance showed a gain in weight in burning rather than a loss when the products were collected. The theory stated that phlogiston was given off when a material burned. He felt sure something must be taken up in burning and so when Priestley discovered oxygen on August 1, 1774, Lavoisier, before reaching his thirty-first birthday, interpreted the discovery, named the new gas, and soon became the master mind among the chemists of his day. His study of the elements and his clearly written textbook not only won the support of the chemists of the time but entitled him to be called the Father of Modern Chemistry. Priestley's discovery which Lavoisier interpreted marks the beginning of modern chemistry—at almost the same time as the birth of the American Republic.

Lavoisier served on countless boards for the advancement of the welfare of the people of France, and used his scientific knowledge to give his country the best gunpowder then known.

Since Thomas Jefferson was born April 13, 1743, he was only thirty-three when he wrote what is declared by Chinard to be "not only a historical document," but "the first and to this day the most outstanding monument in American literature." That so young a man, born and raised on the frontier of the Colony of Virginia, could have done this indicates not only innate ability of a high order, but also well-directed study and rigorous training. The fact that he spent two years at the College of William and Mary and was at home not only in Latin and Greek but also in several modern languages is not so much of an explanation as that made by his biographer in the *Encyclopaedia Britannica*, "Industry and scholarship were the secret of his success." He "disciplined himself to habits of study."

His background was good; his father, Peter, was forceful and well-to-do, though not rich, and his mother, Jane Randolph, was from one of the most distinguished families in the Province. But he knew more than languages. He knew enough of higher mathematics that "throughout life he made practical use of the calculus." As he himself said, "Nature intended him for the tranquil pursuits of science, in which he found infinite delight," and to which he longed to return.

But there were so many demands upon young Tom Jefferson that science could only share his attention and contribute to make him a well-rounded, vigorous, efficient man without whom our country would not have existed just as it does today. Many states are in the area acquired by the Louisiana Purchase, for which Jefferson was responsible. He was "notable for his efforts to secure scientific exactitude." His knowledge was broad and included many fields. Admitted to the bar at twenty-three, he became

a successful lawyer but did not practice long, for he had to look after his thousands of broad acres with more than one hundred slaves. He designed a more efficient plow, understood mapmaking, and knew something of paleontology, ethnology, and botany. He is recognized as the Father of our National Architecture. For eighteen years he served as President of the American Philosophical Society with headquarters at Philadelphia.

Jefferson served as a member of the Continental Congress, the Virginia legislature, Minister to France, Governor of Virginia, was the first Secretary of State, the second Vice-President, and the first President to be inaugurated in Washington. He lived for fifty years to a day after the signing of the Declaration of Independence.

He was a great democrat, believing in the people and their judgment when based on education. "He formulated as perhaps no other American of his generation, an educational policy for a democratic state."

Jefferson, as Minister to France, and Lavoisier were both friends of Pierre Samuel du Pont de Nemours, only four or five years their senior. Du Pont was a man of energy and influence, loyal to the King and appointed to numerous positions of honor and service. Jefferson considered du Pont the leading man of France. Of Lavoisier, du Pont said, "I have never known a man more willing to sacrifice fortune for friendship or the public weal."

In 1787, two years before Lavoisier's great *La Traité de la Élémentaire Chimie* was published, sixteen-year-old Eleuthère Irénée du Pont, son of Pierre Samuel, began work at the Arsenal under Lavoisier and remained there for nearly five years until Lavoisier was transferred to the Treasury.

Darker years followed; Lavoisier was executed for no real reason, both Pierre and Irénée du Pont were arrested, their printing business was ransacked and their lives were in danger. Then the father decided that the family should move to the land of promise, America, where Victor, Irénée's older brother, had already gone.

After a voyage of ninety-one days the du Pont party of seven adults and six children reached Newport, Rhode Island, on New Year's Day, 1800. Many ambitious plans of the senior du Pont did not prove practical. Then after nearly a year Irénée went hunting one day with a French-born, American artillery officer. The hunting was good and soon the ammunition was gone. In buying more the quality was found to be poor, although the price was high. This gave an idea which sent young du Pont back to France to seek financial support for his venture and machinery for his powder mill. Successful in his efforts, he was back in America by July. A site had to be chosen. After due consideration the Broom farm, four miles west of Wilmington on the Brandywine, was selected. The willows growing in this vicinity, which would make excellent charcoal for black powder, are said to have been one factor in the decision. E. I. du Pont, his wife and three children made the crude stone farmhouse their home. Not far away the powder plant was built. At first this was called Lavoisier Mills by Irénée because they "would never have been started but for his kindness to me."

The skill and energy of the founder made the mills successful, furnishing powder of fine quality. Jefferson, then President of the United States, recommended that powder should be bought from du Pont. In the War of 1812 and in every other war of this country since that time, the du Pont Company has been a chief source of munitions.

Resting on the principles clearly set forth by Lavoisier, the science of chemistry has steadily grown in breadth and importance. United with the skill, business ability, and forcefulness represented by du Pont, it has produced an industry bringing countless products for the benefit of all men.

In 1816 Jefferson wrote the following to du Pont senior, who had returned to France: "Enlighten the people generally and tyranny and oppression of both mind and body will vanish like evil spirits at the dawn of day."

This generation faces a crisis in the world's history and an unparalleled opportunity. To meet it we need the United Front given by the ability and vision of broad-minded, liberty-loving statesmen, such as Jefferson, the scientific spirit of accuracy shown by Lavoisier, and the efficiency and resourceful daring of businessmen like E. I. du Pont. And these must be supported by intelligent men and women everywhere.

THE NEW HENRY GEORGE

By G. R. DAVIES

WHILE we are not at all likely to accept the totalitarian philosophy, the experience of Russia may nevertheless serve to teach us a lesson in theoretical economics. It is a lesson which has been pointed out before, but which has never been regarded as important. Of all our economists, perhaps Henry George came the nearest to suggesting it, but he failed to see its full implications.

When the Russians adopted modern cost accounting methods for their ambitious corporate system, they made the simple discovery that the cost of human services—wages of management and labor—by no means equaled the value of produced income. If, however, all items of capital equipment, such as real estate and machines, were accorded their imputed earnings, then accounts balanced. In other words, as we well know from our own experience, the cost of production, in the broad meaning of the term, is represented by the earnings of capital and labor. Theoretically, in perfect equilibrium markets, a unit of labor, land, and machinery each gets the value it adds to total production.

But this matter of costs is only preliminary to the essential point of the discovery. Conventional economics has always assumed that private earnings may be broadly classified as payments for personal services and payments for saving. To us, payments for saving are as necessary and as justifiable as payments for services. It is the theoretical aspect of this conclusion that the Russian experience questions.

If a corporate system could start its books, as the Russian system did, without the usual credits to owners of private capital, it would absorb the earnings which we call interest, dividends, and the "unearned" portion of profits. It then would have ample savings without paying for saving. However, if it began in conformity with free enterprise, and built its corporate structure by crediting investors, then its capital earnings would eventually go to investors, even though temporarily plowed back. And it would be obliged to hold out the attractions of interest or dividends to insure further investment. Practically speaking, a system thus established could not be materially changed.

Just what percentage of total production is theoretically allocated as capital earnings we do not know. Undoubtedly it varies from one country to another, and from one stage of development to another. Moreover, it could be modified by withholdings or bonuses. But on the basis of markets as indicated by our own experience, such earnings probably would have approximated 30 percent in the early days and 25 percent in recent times, while normal savings shortly before the Great Depression were estimated at 20 percent. If these estimates are correct, collectively we have been paying investors 25 percent of our aggregate income to induce them to save 20 percent of it. But the high cost of saving guarantees relatively free competition, and prizes for the winners. On farms and in highly competitive small businesses these prizes may be small. But unearned increments and monopolistic profits should round out the aggregate payments for saving.

The principle involved in capital earnings has an interesting relation to the theories of Henry George and the so-called single tax. Henry George argued that the earnings of land represent in effect a tax which individuals levy upon society, and which should be recovered by the single tax. But he failed to note that the original earnings of land provided funds for the early stages of capital investment. And these investments in turn, combined with land rent, supplied later capital. Consequently it may plausibly be argued that in the aggregate practically all capital earnings are theoretical derivatives of land rent, though over the years individuals may have confused the issue by buying and selling the properties which yield these earnings. Capital, therefore, may be said to possess an effective taxing power. Its levies may be called a natural tax, because they arise naturally from an equilibrium

market. Obviously this natural tax could not now be recovered by an enlarged single tax without destroying free enterprise. Moreover, the taxing power of capital may be defended on grounds of expediency. But at least it emphasizes the truth of the traditional religious principle that wealth is a trust fund.

The fact of capital's natural tax helps to explain some of the phenomena of history. In a new country free enterprise doubtless stimulates a rapid rate of progress, inasmuch as it offers large bonuses to successful tycoons. But as the country matures and wealth settles in the hands of an hereditary class, the incentive to take risks lessens. As markets become complex, as inherited capital loses its initial spirit of enterprise, as diminishing investment returns are experienced, and as depressions become common and extreme, free enterprise systems tend to pass over into plutocracies, dictatorships, or militaristic empires.

The earliest records of civilization, written on the clay tablets discovered by archeologists in the Tigris-Euphrates Valley, reveal free enterprise in full bloom. But various retarding factors, such as those just mentioned, produced rebellions, wars, and empires. Then progress slackened.

Through the centuries of economic history, free enterprise has been revived again and again in frontier areas, or in old areas by the influence of improved transportation. And in each new frontier, as a rule, business has climbed to higher levels of invention and power, and has often revived old reactionary centers. Now that we are shedding our isolationism, new geographic frontiers should keep us busy for a generation or two, assuming the usual clashing of rival imperialisms. After that, only the frontiers of new science will remain. But these frontiers so quickly yield enlarged investment funds, that a paralysis of enterprise may again ensue.

If modern democracies are to escape the historical fate of free enterprise systems, there must be an advance in social science comparable to that which has occurred in the natural sciences.

SCIENCE ON THE MARCH

SOIL ACIDITY—A NUTRIENT DEFICIENCY

Soil acidity has long been considered a dangerous soil condition for plant growth. This accusation has resulted, however, as recent researches show, because of fallacious deductions from correct observations rather than from experimental establishment of the fact.

When the application of lime as calcium carbonate or oxide reduced the degree of soil acidity and simultaneously improved the growth of plants, this observation led to the belief that the one of these two concomitant phenomena was the cause of the other. It was this common fallacy of logic, namely that of ascribing causal connection between contemporaneous manifestations, that has for years been responsible for the conclusion that soil acidity *per se* is dangerous. It has also led to the persistence of the equally erroneous corollary that soil neutrality must be beneficial.

Research studies in the Department of Soils, College of Agriculture, University of Missouri, show that soil acidity *per se* is not injurious to plant growth within the limits of degrees of acidity common in soils. When the clay fraction of the soil takes on hydrogen to give acidity other elements of positive electrical charge but of nutrient value are given off. It is then the deficiency of nutrients, or plant starvation, that is detrimental to the crop when the soil becomes acid. It is the exit of the nutrient elements rather than the advent of the acidity in the form of hydrogen ions that is the cause. Liming is beneficial because it applies calcium, which is a plant nutrient, rather than because its carbonate neutralizes the acidity.

These facts have been demonstrated by using carbonate compounds of elements other than calcium, particularly of sodium, a non-nutrient for plants. Neutralization of the soil acidity by the carbonate of sodium is not as beneficial as is the application of calcium carbonate. This demonstrated the fallacy in ascribing the beneficial effects of applied limestone to its acid-neutralizing property. That it is calcium that exerts the beneficial effect has been demonstrated by fertilizing plants on acid soils with calcium compounds that do not neutralize acidity; for example, with calcium chloride and calcium sulfate. These were beneficial to the crop growth even though there was no reduction in the degree of acidity of the soil. Consequently, the addition of the calcium and not the reduction in the degree of soil acidity is the beneficial factor in liming.

It has also been demonstrated that crop growth creates significant degrees of acidity by its removal of the nutrient elements or ions from the clay. The plant's contribution of hydrogen to the clay and the removal by consumption of other positively charged elements replaced by the hydrogen as an exchange was the action making the soil acid. Removal of nutrients from the soil either by plants or by leaching waters brings on the acidity of the soil. We have been focusing attention on the entrance of the hydrogen to the disregard of the loss from the soil of the many plant nutrients that are exchanged in letting the hydrogen take their place.

Furthermore, soil acidity, or hydrogen in the soil, is beneficial in moving nutrients into the plants. Spinach was grown with constant soil conditions as to nutrient supplies, but in one crop series the reaction of the soil was acid while in another it was neutral. Chemical analyses of the crop showed the spinach grown on the acid soil to be well supplied with the soil-borne calcium and magnesium. Analyses were not made for all the elements. The crop had less oxalate than that required to make all the calcium and magnesium insoluble or indigestible. The spinach grown on the fertile acid soil was a deliverer of good concentrations of these two mineral nutrients.

The spinach crop grown on the fertile neutral soil was quite the opposite. The concentrations of calcium and magnesium in this vegetable were much lower. The oxalate concentration was so high that it would make insoluble, not only all the calcium and magnesium in these greens, but also additional calcium in other foods that might be mixed with the spinach in the stomach.

Research has thus clearly demonstrated that the natural acid condition of the soil is largely a case of nutrient deficiencies. It has also demonstrated a more efficient use by the crop of the applied nutrients when such applications allow the soil to remain acid. Much remains to be worked out about the relation of soil reaction to plant nutrition, now that we can approach the task in terms of these newer experimental facts.

WM. A. ALBRECHT

STANDARDS

IF materials for industry and finished products for consumers were permitted to vary without restriction in design, size, and quality, life would become markedly more complicated, unsatisfactory, and expensive, and our standard of living would fall. Consequently both industry and large buyers have increasingly developed standards and specifications for the goods they make and buy. L. F. Adams and P. L. Alger in *Industrial Standardization* have defined standards as "accurately defined processes, sizes, qualities, and tests of materials and equipment that have been generally agreed upon by makers, users, and the public as proper and desirable for general use." Such standards, they believe, have four distinct values:

They educate. They set forth ideals, or quality goals for the guidance of manufacturers and users alike. They are invaluable to the manufacturer who wishes to enter a new field, and to the naive purchaser who buys a new product.

They simplify. They reduce the number of sizes, the variety of processes, the amount of stock, and the paper work that largely account for the overhead costs of making and selling.

They conserve. They save the losses of defects, left-over pieces, and inadequate tooling that must accompany odd-lot manufacture, by allowing large-scale production of standard designs. Each step in this direction justifies better tooling, more careful design, and more precise controls, all conserving both time and materials.

They certify. They serve as hall-marks of quality of inestimable value to the advertiser who points to proven values, and to the buyer who sees the accredited trade mark, nameplate, or label.

It might be supposed that science does not march with the conservatism of standards but only with the innovations of discovery and invention. But science does play a part in the establishment of standards, particularly of those dealing with performance of products. As an illustration, let us consider liquid household insecticides, which consist of a highly refined kerosene in which certain insecticidal substances are dissolved and which are sold under innumerable trade names.

Not so many years ago the buyer of "bug juice" had no assurance that Better Bug Bane, to coin a name, consisted of anything more potent than perfumed kerosene. He bought whatever the druggist had for sale and hoped for the best. The National Association of Insecticide and Disinfectant Manufacturers felt uneasy about this situation and set up an Insecticide Scientific Committee to establish standards for reputable manufacturers. Because chemical testing methods were not adequate for evaluating performance, biological tests or assays had to be made against insects. As a result of about ten years of cooperative research on rearing of test insects, test methods, and statistical analysis of results, the NAIDM has adopted a standard of performance for liquid household insecticides against house flies.

Every testing laboratory now uses the "Official Test Insecticide" supplied by the NAIDM as a standard with which to compare the performance of the insecticide to be evaluated. In a prescribed manner and under controlled conditions the Official Test Insecticide is sprayed into a large cubical chamber containing vigorous house flies that are neither too young nor too old. After a ten minute interval, the operator opens the chamber and enters it to pick up and count the flies on the floor, which are dead or paralyzed. Then the whole procedure is repeated on another group of flies, spraying the insecticide to be evaluated. Repeated tests are made of both the standard insecticide and the unknown. Next day the dead flies are counted and the mean mortality caused by the standard and unknown is determined. The NAIDM decided that a salable insecticide should kill on the average as many flies as the standard. Such an insecticide could be labeled Grade B. If the insecticide was potent enough to kill more flies than the standard, it might be labeled Grade A or Grade AA depending on the difference in kill between the standard and unknown. The result of the general adoption of this

standard of performance has been to raise and to level out the quality of most brands of liquid household insecticides. Now if John Doe finds "Grade AA" on a bottle (formerly a can) of Better Bug Bane, he can be reasonably sure that he is getting something for his money.

The story does not end here. The buyer of Better Bug Bane may have bought the product to kill cockroaches or bedbugs instead of house flies. The label says it is good for both; but is it? Will a test on house flies give the answer for other insects? Five years of research sponsored by the NAIDM went into a study of this question. The answer is "no." One insecticide may be best for roaches, another for bedbugs, and still another for house flies. Methods for making comparative tests against roaches and bedbugs were developed and recommendations were made, which may be put into effect after the war. Thus standardization may induce research and be benefited by it.

F.L.C.

NATURAL RUBBER PROJECTS

WITH the invasion of the Dutch East Indies by the Japanese, the Forest Service of the U. S. Department of Agriculture, largely in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering, promptly undertook further search and experiments for natural sources of rubber other than the Hevea tree. Less than six months after the attack on Pearl Harbor nurseries were established in California for planting 21,000 pounds of guayule seed, which was all then available. During the first year 23,470 acres were planted to guayule in California and 831 acres were planted in the other southwestern States. Seven nurseries located in California, Arizona, New Mexico, and Texas, and having a combined area of 3,439 acres will be able to supply the planting requirements of the Rubber Director for the fiscal year July 1, 1943–June 30, 1944.

Surveys of available wild guayule in Mexico and Texas have been completed and harvesting operations of the wild shrub are under way. In addition, surveys are being made to determine the areas in California, Arizona, New Mexico, Texas, and Mexico that have suitable climatic, soil, and moisture conditions for growing guayule successfully. The information provided by these surveys is available to all desiring to make experimental plantings. Technical assistance and nursery stock have been given to several South American countries, seeds for experimental purposes have been supplied to a number of foreign countries, and the Bureaus have carried out cooperative experimental plantings in Mexico.

From native, cultivated guayule shrubs grown in California in 1942 a total of 440 tons of guayule rubber of high quality was extracted. This quantity is enough for many experiments on properties of the rubber obtained, but neither the planting nor the processes of extracting the rubber have yet been on a sufficiently large and varied scale to justify a conjecture regarding guayule as a competitor of the Hevea tree or the recent synthetic processes discussed in the January issue of *The Scientific Monthly*.

It has long been known that the ordinary goldenrod is a source of a natural rubber (of course, different plants produce different rubbers) that might possibly be of commercial interest. Accordingly, the bureaus interested in natural rubbers organized an experimental goldenrod program of 650 acres near Waynesboro and Savannah, Georgia. Contracts covering land preparation and crop cultivation were entered into with owners of the better types of cotton land. The investigations under way include also the adaptation of standard equipment in planting, harvesting, and drying the leaves of goldenrod.

Another possible source of natural rubber is the Russian dandelion (kok-saglyz). It was found in the preliminary experiments carried out in 1942 that the roots of this plant yield about five percent rubber. These results stimulated the planting of 700 acres last year in thirty-five test fields distributed from Oregon to Vermont.

A part of both the goldenrod and the Russian dandelion crop raised last year was harvested at the proper stage for rubber production in order to extract a few tons from each for experimental purposes. The magnitude of the problem of securing natural rubber from plants that can be grown in the United States, and the vigor with which this

problem is being attacked, are indicated by the fact that the Forest Service expended on its Emergency Rubber Projects in the fiscal year ended June 30, 1943, a total of $20,752,801.—*Digest of part of the report of the Chief of the Forest Service, Lyle F. Watts, for 1943.*

EXPLORER OF CELESTIAL SPACES

YALE UNIVERSITY was fortunate in having on her staff for more than twenty years two of the most distinguished astronomers of our time, Ernest Brown and Frank Schlesinger. Both were devotees of austere and exacting branches of their science; both enriched them with important new methods and devices; both rose to unquestioned primacy among living workers in their fields. The recent death of the second prompts this account of the work which has given him a lasting place in the annals of his science.

His special field, the astronomy of position, is as much an art as a science. Its main problems—where the heavenly bodies appear to be, where they are, and how they are moving—may be solved in principle by simple geometrical means. Its methods have gradually been perfected until they are accurate to one part in a million or better; but the quest for such precision unveils many unsuspected errors. To distinguish between those arising from the inevitable, but accidental, imperfections of observations and those which can be got rid of only by improving the conditions of observation requires skill in applied mathematics and statistics; to find the causes of the latter demands a thorough study of every detail of the apparatus, including the psychology of the observer; to devise ways of avoiding or correcting them needs also inventive skill; and to organize a program of research so that results of the highest precision can be obtained efficiently and at a minimum cost of labor and money is a matter of engineering and economic management. In all four of these capacities Schlesinger was a master.

His opportunity came in 1903, when the Carnegie Institution sent him to the Yerkes Observatory for photographic observations of stellar parallax—in plain English, to measure the distances of the stars. The primary need here is to measure the position in the heavens of the selected parallax star, with reference to fainter reference stars in the background, and with all possible precision. Visual observations with the heliometer were more precise than by any other method then known, but they were extremely laborious. About the year 1900 it became evident that still more precise observations could be made by photography.

The gelatine film of an ordinary plate sticks to the glass with amazing tenacity, so that measures of good star images are reliable to 1/10,000 of an inch or better. To reap the benefit of this accuracy, many precautions are necessary in the taking, in the measurement, and in the reduction calculations. Schlesinger's methods set the standards which have been, and still are, employed in thousands of parallax determinations at many observatories during the past thirty-five years. No substantial improvements upon them have yet been devised.

Some of these methods were of his own invention. For example, if the plate is exposed long enough to get good images of the faint reference stars, that of a bright star will be too over-exposed and fuzzy to measure. Schlesinger cured this by mounting above the plate a small metal disk with an adjustable open sector, which was spun rapidly. This cut off the light of the bright star except for a series of short flashes. This series of snap-shots produced a star image which, with proper adjustment of the sector, was as small and sharp as the images of the other stars, and proved to be as accurately measurable. This simple device has enabled the observation of thousands of naked-eye stars, even the brightest.

The measures on the plates have to be reduced to a common standard. This was formerly done by calculating a correction formula for each plate, and then applying it to the parallax star. Schlesinger showed by simple algebra that the desired result could be obtained directly by taking the differences between the measured position of each reference star on the plate from the standard and averaging them in a particular way with the aid of factors called "dependences." With fifteen or twenty plates to work up, this saved a great deal of time.

In 1905 Schlesinger was called to the direc-

torship of the Allegheny Observatory, and took an active part in its reorganization. Generous aid was provided by the people of Pittsburgh and the vicinity, the Observatory was moved to a new and favorable site, and a great telescope was installed. At such a time, it was even truer than usual that the primary need of an observatory is a first-class director. Schlesinger's peculiar gifts came into full play—his foresight and sound judgment in choosing fields of work, and his grasp of their essential requirements both in instruments and methods. The great refractor was designed exclusively for photographic work, and is still the most powerful existing instrument for its purpose. With this he began an extensive program of observations for stellar parallax, which is still being continued at the Observatory. It was found that the city smoke, though dimming the brightness of the stars, had no ill effect upon the sharpness of their images, and the long series of Allegheny parallaxes, now more than 1500 in number, are of very high accuracy.

One feature of this program illustrates his scientific conscientiousness. The minute and unavoidable errors in even the best observations once in a while make a calculated parallax, which would be small anyhow, come out negative. This is an absurd result. Parallax observers are human, and the temptation is very strong to take a new set of observations on the star in the hope of getting a more reasonable result. To throw away the old value and substitute the new would be scientifically immoral, but Schlesinger realized that even to take the average of the old and new results is not really playing fair. It amounts to correcting those cases in which the errors of observation make the result come out too small and ignoring the equally numerous cases when they make it come out too great; and this vitiates the general average. Therefore Schlesinger left "warts and all" in his list and kept on observing more stars.

Much excellent spectroscopic work was also done at Allegheny by Schlesinger and his associates, and the orbits of many spectroscopic double stars were determined. The formulae which he developed for the precise calculation of these orbits are still in general use. Special mention should be made of his work on the eclipsing binary u Herculis—one of the very first instances in which the actual sizes, masses, and densities of a pair of stars were deduced exclusively from observation. He was the first to point out (in 1909) that when the brighter star of such a pair is going into eclipse the unobscured portion of its disk will, on the average, be moving away from us, owing to its rotation; and contrariwise when it is coming out, an effect that has proved to be of considerable importance.

Turning to less technical matters one may recall the smile with which he used to tell how an unexciting paper, "The Orbit of 25 Serpentis," came from the printer with the title "The Orbit of Twenty-five Serpents"—the most sensational astronomical headline on record!

In 1920 Schlesinger was called to Yale, where he remained as Director of the Observatory for twenty-one years. He found a long-established astrometric tradition, which he continued and expanded in two directions. A photographic refractor of 26 inches aperture was installed at Johannesburg, South Africa. With this instrument the parallaxes of more than 1600 southern stars have been observed, under the direction of Dr. Alden. This major contribution to knowledge has had interesting by-products, including several cases where a star has been found to be in orbital motion about the center of gravity of itself and an invisible companion.

Schlesinger's last contribution in this field —and one of the most valuable to astronomers—is found in his general catalogues of stellar parallaxes, in which the results of all observers are collected, critically examined, corrected for their minute outstanding errors, and combined into mean values. The preparation of such a work demands the highest degree of knowledge of the subject, and impartial critical judgment. Subsequent studies have not only confirmed his conclusion that his catalogued values are, on the average, systematically correct within a thousandth of a second of arc, but have shown that the probable errors assigned to their individual values substantially represent their real accuracy—an achievement almost without precedent. A star having a

parallax of a thousandth of a second of arc is at a distance of about 200,000,000 times the distance from the earth to the sun.

Schlesinger's second main activity at Yale was the planning and preparation of the great photographic catalogues of star positions. Accurate determinations of the apparent places of stars in the heavens could formerly be made only by visual observations with the meridian circle. But such observations are laborious and costly, and it is much more economical, as well as more accurate, to determine a smaller number of reference stars in this way, and then use photographs to fill in the others between them. Here plates covering a large area in the sky have a great advantage. About the same number of stars are required per plate as reference points whether this is large or small; hence the total number of such points needed to cover a given large zone of the heavens varies inversely as the area of the plates.

This raised a set of new problems, for example, to design lenses for wide-angle cameras so that accurately measurable star-images could be secured all over the plate; to extend the methods of reduction so as to take account of many terms which were negligible on small plates and important in large ones; and to devise economical methods for handling the enormous amount of measurement and calculation involved.

Special measuring engines were designed to handle the larger plates with precision, and special and very ingenious methods of reduction were developed.

With the ordinary measuring-engine, the observer looks into an eyepiece, and turns a micrometer screw to set a fine "wire" (spider-thread) on the magnified star-image. Then he draws his eye back, reads the micrometer head, and writes down his result. This demands re-focusing the eyes three times for each measure, and the resulting eye-strain prevents any one from measuring habitually for more than an hour or two per day.

Schlesinger designed a simple optical system attached to the eyepiece, such that an enlarged image of the star-image and wire were projected down on a white surface at the same distance from the observer's eye as the micrometer head and the record-sheet. The number of hours of measurement per day could then be approximately doubled, with no increase of fatigue—and so the worst "bottle-neck" in the whole scheme was widened.

The results were impressive. The nine volumes of Yale Zone Catalogues so far published contain accurate positions of more than 91,000 stars; while catalogues including 55,000 more are in various stages of preparation—an amazing output for a single observatory of moderate resources. The precision of these observations considerably surpasses that of the older catalogues observed by other methods, and the hours of observing and computing-time were very much less.

The economic efficiency, as well as the accuracy, of the Yale Catalogues gave him justifiable satisfaction; yet he generously insisted that the Lick Observatory, at which the meridian observations had been made to determine accurate and up-to-date positions of the reference stars for the first catalogue, had made fully as great a contribution to it as Yale had.

The large plates used for the later series cover so great an area of the sky that enough reference stars may be found among those which have already been accurately observed so that this special collaboration is no longer necessary.

Nineteenth-century observations of reference stars could not be used for determining the positions of other stars, not because the earlier observations were inaccurate, but because the stars themselves had moved in the interval. The Yale Proper Motions, by comparison with the older observations, give accurate values for the motion of many thousands of stars. Only a very small part of the store of information contained in them has yet, in these troublous times, been evaluated. The rest will be Schlesinger's monument.

BOOK REVIEWS

THE OLD WORLD ROBIN*

THE old saying "good things come in small packages" applies very well to this unprepossessing little book. Students of bird behavior who have been looking forward to the appearance of David Lack's study of the robin may be disappointed with their first impression of it, but they will soon become convinced that any meagerness it may have is in its format and binding and not in its content. In a sense, this work, based on a number of consecutive years of intensive observation of one of the commonest and most popular of European birds, is a European counterpart of Mrs. Nice's study of the song sparrow in this country. Both are very rich in detail, in the sort of factual minutiae that are not elsewhere available; both are characterized by an underlying pattern that serves to give coherence and significance to what would otherwise be merely a mass of unrelated, or at least, uncoordinated items of information. Lack's book is, in addition, much better reading from the literary viewpoint.

To a large extent, Lack's observational data are based on marked, individualized birds, and have therefore a definiteness and precision all too rare in field biology. This, together with the author's inclination to see the problems in the material at all times and to extend his thinking from the limits of his notes on a single species to wider horizons, makes the book stimulating and provocative as well as informative. In his first chapter, Lack outlines his methods of trapping and of individual marking of birds, and describes the aviaries in which he kept some individuals for special observations. Then he proceeds to discuss, with illuminating effect, innumerable topics centering around the main ones of song, fighting, pairing, courtship, reproduction, territory, migration, food, plumage pattern, age, recognition, and tameness. To take, for example, the first of these larger subjects—that of song; we are given some detailed data and stimulating queries on the song period, the individual variation of song, the audible versus the inaudible parts of song, song in relation to territory, female song, song as a preventer of fights, "battle music," singing for mates, singing when alarmed, mimicry, the significance of song in late summer, and the question, "is song inherited or acquired?"

A final chapter, "A Digression Upon Instinct," makes a worthwhile philosophic, retrospective summation of the type of problems dealt with in the earlier chapters. All through the work one is impressed not only with the author's intimate acquaintance with the robin, but also with a wide range of literature immediately bearing on his subject. Literary sources also provide a cultural setting for the reflections of an educated man upon one of his humbler, but much cared for, fellow mortals.

The reader of this review may be cautioned that the robin is not our American thrush, *Turdus migratorius,* but the quite different, much smaller, Old World bird technically designated *Erithacus rubecula.* Bibliographical references are listed by chapters at the back of the book, and there are two indices, one to species of birds, and one to persons mentioned in the text.

HERBERT FRIEDMANN

* *The Life of the Robin.* David Lack. 6 illustrations. 200 pp. May, 1943. 7/6d net. H. F. & G. Witherby.

CANCER RESEARCH REVIEWED*

The Biochemistry of Malignant Tumors is a sincere and painstaking attempt to review and to integrate the findings of research in the problems of cancer. The literature for the past twenty-five years is well covered through 1941; 5,000 references are quoted within 950 pages. The title of the book is somewhat a misnomer, for it is actually an annotated bibliography of many phases of cancer research, including fields which can be placed under biochemistry only by very broad definition. A more critical evaluation of many subjects and apparently contradictory individual findings is curtailed by the attempt to make the volume too inclusive,

* *The Biochemistry of Malignant Tumors.* Kurt Stern and Robert Willheim. 951 pp. 1943. $12.00. Reference Press.

as well as by the authors' acknowledged lack of first-hand experience in many of the fields. These and many other criticisms that can be made of the book are recognized in the authors' disarming preface. Most of the ten chapters terminate with brief, conservative summaries in which no attempts are made to introduce or to advocate any cancer theory.

The book will be useful and stimulating to the worker actively engaged in experimental oncology in that it refers to original sources in a multitude of subjects and furnishes general conclusions reached by the authors of the original papers. For the casual reader, however, greater critical evaluation is desirable; for the expert, the material is presented too incompletely to be used without reference to the original reports. Symposia by experts in individual fields would be more informative for the general scientist, and a complete, up-to-date Index Oncologicus is a real need of the workers in cancer research.

It is of interest to indicate some of the general conclusions reached by the authors after the examination of almost 5,000 papers and books written by over 3,000 individuals. One is immediately struck by the lack of definitive generalizations. The reader cannot but wonder at the contradictions and the apparent paucity of conclusions from the large amount of work already performed. In the reviewer's opinion, the great differences in etiologic factors and in the biology of different tumors is so striking that cancer, as Ewing and others have stated, must be considered as a great group of diseases rather than as one entity. Our knowledge about a sufficient number of separate neoplastic diseases has not reached the stage of analysis prerequisite for a coherent synthesis of the information about neoplasia in general. Viewed from this standpoint it is unavoidable that, in any compilation of the information available at present, the real advances in specific lines of investigation and on specific neoplastic diseases be obscured by attempts to formulate conclusions concerning cancer in general.

The Biochemistry of Malignant Tumors is the only book of its type available in the English language; it will prove of definite although limited value as an annotated bibliography. Typographical errors are frequent and, considering the price of the book, the format is poor. It is hoped that this work will be a stimulus for further and improved additions to the literature of experimental oncology—a need felt by many of the workers in the field.

MICHAEL B. SHIMKIN

FIRST AID THAT AIDS*

THERE is now available a modern text on first aid which is truly comprehensive and splendidly maintains that rarely achieved balance of being neither too technical nor too elementary. This is an advanced guide and goes well beyond the majority of previous works on the subject, many of which have had to sacrifice accuracy to remain elementary. The style is lucid, brief, and precise without being dogmatic. The editors have presupposed intelligence and attention on the part of the reader, which is a refreshing attitude in first aid texts.

The book is comprehensive, including all that needs to be known for the wise application of first aid as an emergency measure. Included is a brief consideration of the general principles of first aid, a short discussion of normal human anatomy with emphasis on the functional aspects of structure, the principles of bandaging, the management of various forms of wounds, control of shock and of hemorrhage, the immediate care of burns and frostbite, the problem of transportation of injured persons, discussion of fractures, aid in respiratory emergencies and visceral injuries, head and central nervous system injuries, medical emergencies, and specific consideration of the field problems of gas and bomb air raids. The editors have called upon seventeen of their associates in the various medical specialties at the University of Illinois College of Medicine for chapters dealing with problems within their special fields. Thus, the work is unusually authoritative as well as being more comprehensive in scope than any other previous text in this field seen by the reviewer.

According to the preface, the editors prepared the text primarily for the instruction of medical students. It is also an invaluable

* *First Aid: Surgical and Medical.* Warren H. Cole and Charles B. Puestow. Illustrated. xxiv + 351 pp. 1942. $3.00. D. Appleton-Century Company.

source of practical information for physicians, many of whom are decidedly rusty on questions of first aid. Admittedly, quite a few of the procedures suggested are definitely beyond the scope of non-medical first aid enthusiasts. Far better temporary neglect than over-zealous ill-advised therapy! However, the authors recognize this hazard and repeatedly stress the importance of exact knowledge before attempting to do anything at all. It is their contention that the cure for "a little knowledge is a dangerous thing" lies not in maintaining a state of ignorance but in extending education. In this concept we heartily concur. The more informed an individual is, the more fully aware he is of his limitations. The book, therefore, should not be limited in its usefulness as a textbook for medical students or a refresher volume for physicians; it can, and should, be extensively employed as a text in college courses where first aid, elementary anatomy and physiology should be subjects required of all students. The ignorance of presumably "educated" persons regarding the structures and functions of their own bodies is appalling. This ignorance makes the task of physicians in maintaining health much more difficult than need be.

Splendid and liberal illustrations not only clarify the text so that no confusion of intent is possible, but definitely add much valuable information. In time of peace, the tremendous incidence of accidents makes the knowledge of first aid valuable to all; in time of modern war, with the threat of civilian bombardment always present, training in first aid becomes a civic obligation.

EDWARD J. STIEGLITZ

MEDICAL SCIENCE*

THIS book represents the product of an ambitious undertaking, namely, a survey of the history of medicine, the etiology, pathogenesis, pathology, diagnosis, and treatment of disease, and a consideration of the field of public health, with all its ramifications. It is designed primarily for the student nurse, but suggested by the authors as of value to the graduate nurse, laboratory technician, social worker, and others in similar fields.

In many respects, the book succeeds admirably in its purpose. In general, the chapters on diagnosis of disease are excellent, being comprehensive and clear, as is the discussion of therapy. The section on control and prevention of disease includes summaries of the federal and state health programs, measures for the control of food and water, industrial hazards, and other important public health problems. However, the subjects of bacteriology and immunology are given insufficient attention in this text. All infectious diseases are grouped under a brief consideration of "endogenous toxins" in the chapter on causation of disease. Here, nothing is said about predisposing factors, routes of infection, or the interaction between the same organism and host depending on the site of entry of the former. In the same chapter, allergy is very cursorily treated, and a misleading statement is made in the description of anaphylactic shock, as a "phenomenon related to hypersensitivity, except that it manifests itself as a spasmodic contraction of smooth muscle."

Bacteriological diagnosis is incompletely described, and the differences in procedure depending upon the type of organism, stage of the disease, presence of secondary invaders or normal flora, and other factors, are largely ignored. An example of this is the statement on page 221, "the typhoid-dysentery group of organisms is isolated by culture on Endo's medium, and then identified by macroscopical agglutination in immune sera," which is certainly an over-simplification of a complex method. Similarly, the discussion of therapy by immune sera is inadequate. The subject is not put on a reasonable basis. Further, little is said about dosage, time or route of administration of immune serum as affecting the success of its action. The same criticism may be made of the discussion of serological procedures as an aid in diagnosis; the Wassermann test is outlined as if the reaction were specific, as is the heterophile agglutination test for infectious mononucleosis. There is no good outline of the fundamental bases of antigen-antibody reactions as a preliminary to presentation of their applications. It might be argued that it is not the purpose of this book to discuss applications of bacteriology and im-

* *Introduction to Medical Science.* Gulli Lindh Muller and Dorothy E. Dawes. Illustrated. 454 pp. 1943. $3.00. W. B. Saunders Company.

munology in detail. It is apparent, however, that chemical and other types of tests are described much more adequately. For example, the colloidal gold test receives a page and a half of explanation, including a chart and color plate.

The book is an undoubted contribution to nursing texts. It would be greatly improved by revision of the sections dealing with bacteriology and immunology to give a more fundamental approach to these subjects. A glossary or explanation of technical terms would be of considerable value.

The illustrations for the most part are excellent. The book is well bound and printed.

MALCOLM H. SOULE

GENES AND THE MAN*

TAKING as his thesis the concept that man is intelligible only as we perceive what has made him as he is, and that thus genes and chromosomes are important to us only because of the effects they produce during the course of growth and development, the author of this stimulating volume proceeds to trace the sweep of an individual's development and progress from their beginnings in the protoplasm and genes through maturity to decline and death. The welding together into a single connected story of the events of genetics, embryology, and physiology is a laudable though difficult undertaking, but Doctor Glass has made a noteworthy success of it. The book is critical and thorough, and its underlying philosophy may be illustrated by a statement made by the author in connection with the study of mitosis: "We should be on our guard lest we take a very superficial knowledge for real understanding."

The book starts with a readable and understandable account of cells and cell division. Then follows a concentrated chapter on meiosis, mutation, and the basic facts of genetics. The biology and physiology of sex determination are considered in a broad and thorough account. The fourth chapter considers the question of how genes act: the modern concepts of growth and development. Much recent research is cited here and woven into a well-connected story.

A long yet highly condensed chapter traces the embryological development of man. Should the book be used as a text, this chapter especially will require much "teaching." It is an excellent over-view of embryology without, however, much genetics. This is not the fault of the author, of course, and a commendable attempt is made to tie in genetics wherever such knowledge is available.

The last chapter is on growing old. External and internal factors are considered and, as throughout the book, the relative importances and interactions of heredity and environment are carefully assessed.

A few specific points may be mentioned. The book is beautifully illustrated, and on the whole remarkably free from typographical errors, although some do occur. An occasional doubtful statement is met with. On page 158 the author says ". . . more human genes have been detected in the X than in all the rest of the chromosomes combined," a pronouncement with which few students of human heredity would agree. Grey eyes are considered the heterozygote between brown and blue. In discussing the normal distribution curve resulting in the F_2 generation from multiple blending factors, the author fails to point out that a similar result would occur if the factors showed dominance.

The book is a highly successful attempt to bring together into an understandable mosaic the too often separated fields of genetics, embryology, physiology, and medicine. The author is to be congratulated.

LAURENCE H. SNYDER

* *Genes and the Man.* Bentley Glass. Illustrated. 386 pp. 1943. $3.50. Teachers College, Columbia University.

COMMENTS AND CRITICISMS

War of Words

The new *Scientific Monthly* deserves approval for both the practical and the metaphysical in its content. For example, population problems (Sax) prevent wishful thinking, while mathematical problems (Birkhoff) promote basic thinking. Both approaches seem essential to the solution of imminent human problems. As to population, parthenogenetic pregnancy and hormones in reproductive controls are already suggested by the results of mammalian research as possible in a "new world order." But in any new order "we need more of the scientific method," says Professor Sax, "particularly in the field of social relations and human conduct," as against "abandoning rational thought and reverting to mysticism" in our currently chaotic social evolution. To this end we shall have to resort to metaphysics to overcome the serious lack of synthesis in scientific thought. Technique is not enough.

At present our publications are too much framed by the professional interest of the specialist who jealously guards his "discipline," however trivial. There has thus developed what Peter Carmichael has well called, in his criticism of Irving Langmuir's social philosophy, a "cavalier attitude" toward the controversial metaphysical problems of epistemology by which a scientific synthesis is possible. Science has, indeed, acquired dire and divers delusions of grandeur because of which, in the words of Isaiah Bowman, "the critical spirit is having a hard time." Mathematical theory is so buried in the clouds of the infinite and infinitesimal as to let the so-called "social sciences" erect a Tower of Babel, upon what Thorstein Veblen has satirically called the "hedonistic calculus," and get away with this confusion of tongues by calling it "scientific."

It is here, in the heart of the most acute metaphysical controversy, that science should fearlessly face the problems of politics and religion in seeking truth, not wholly for its own sake, but as that which shall make men *free* in their social relations. Yet there is no *scientific* discipline professionally devoted to such an inclusive synthesis as seems essential if scientists are to escape the just criticism heaped upon them for their grand isolation from social problems. Some publication, where wishful thinking can be overcome in controversy over elemental issues, will have to arise and shine with a beam which will guide us to safe landing in the port of some common denominator. *The Scientific Monthly* has recently by no means avoided such subject matter and it is to be hoped it will open its pages to every possible disputation over the general perspective and orientation of science in its social setting.

In such developments the editors can hardly hope to confine the "experimental section" of the *Monthly* to a few pages of editorial review of "Science on the March." Science is essentially an unfinished business; and a periodical that is read by a professionally diverse clientele is surely such as can best promote progress in synthesis. We would prostitute science to publish a mere heterogeneous compendium of technological information. We cannot keep out of the foxholes of intellectual (moral) disputation if we hope to help in keeping out of the foxholes of war which science has so fearfully implemented.—Alden A. Potter.

Inflation

I have just read the January issue of *The Scientific Monthly* and when a fellow has done a good job, I want to tell him about it. You and your staff have turned out the best issue that I can recall. I find every article of interest—which is more than I can say of some. Congratulations!—Otto Watts.

Deflation

Incidentally, I would not have you think that I consider *The Scientific Monthly* an attractively produced journal from the point of view of format. On the other hand, I consider it one of the poorest. What I wanted to say is that its present format is an improvement upon the old. If I may say so I think that one of your principal defects is the paper you use. Now, it would seem to me, would be a good time to change to a more attractive "wartime" paper. But don't let me get involved in re-arranging the format of another journal. I only have one life-time, and I've misspent too much of that already.—M. F. Ashley Montagu.

Headline and Explanation

I am indeed pleased with the reference to Johns Hopkins University in the January issue of *The Scientific Monthly*. I also find other things of special interest in it. What I do not like is the type used in the title of the magazine. But no doubt you are experimenting with that.—Isaiah Bowman.

Many thanks for your letter of January 5 and the kind remarks you made regarding the contents of *The Scientific Monthly*.

You are the first member of the Association who has objected to the type used on the cover of the *Monthly*. Since the two words *Scientific* and *Monthly* appear to be of equal importance and both of them are rather long, we must either put one above the other or use such type that they can both be on the same line. In advertising I think it is

universally agreed that to have one word above another when they are of equal rank is a bad arrangement. If we put the two words on a line and have type of substantial size, it becomes necessary to use something like the Bodoni which was selected. However much that may fall short of our ideals, I think you will agree that the Table of Contents is now legible without so much trouble as readers had in the old form.—F. R. M.

Propaganda?

Let me question the propriety of giving space in *The Scientific Monthly* for such matter as the article by Dr. Alonzo E. Taylor of Stanford University discussing the United Nations' Conference on Food and Agriculture. Why was a beneficent conference of learned economists such as Dr. Taylor portrays closed to the press? Why was the right of Senators and Representatives in Congress to be present at its sessions seriously called in question?

That policy of its sponsors justifies the public in concluding that its real purposes were sinister and adverse to American interests. The conference was called by politicians and veiled in secrecy by them. Its agenda were prearranged by politicians and they hid its sessions from the public.

Dr. Taylor discloses no incentive for secrecy. But there obviously was such incentive. Otherwise the sessions would have been open. To picture as beneficent and scientific an international meeting whose sponsors were unwilling for the public to know what it was doing seems inconsistent.

Please do not let *The Scientific Monthly* be made the vehicle of secret political propaganda. To do so will not enhance public confidence in its utterances.—Gilbert O. Nations.

Sound and Fury

Since your [A. J. Carlson's] election as president of the Association, I have read several of your recent articles, among them your investigation of science in liberal arts colleges as reported in the *Quarterly* of the North Central Association of Colleges and Secondary Schools.

The conditions that your investigation revealed are disquieting. One of your statements attracted my attention: "*It is easier to gather dollars for bricks than to secure pennies for brains.*" This statement of fact seems to require different remedies than any you proposed. Consequently I sketch one for your consideration, which has for its purpose very great improvement in teaching of all college subjects at inappreciable financial cost. It sounds as though there were a catch in it, but you know I am not subtle.

The suggestion: Let each college purchase sound recording apparatus and make records of three class sessions of each instructor without his knowledge or the knowledge of the class. Simply let every instructor know that recordings will be made sometime during the year. After the recordings are made, let the instructor hear his records and decide which of the three is most nearly typical of his work. Then have faculty parties from time to time at which the recordings are reproduced, all of them at least once during the year. I rest my reputation as prophet on the prediction that this innovation would very promptly result in a great improvement in teaching.

I wish you would develop this subject into an article for *The Scientific Monthly*. Your active imagination will detect many advantages of the proposal. For example, if an instructor who reads the same lectures year after year should contract the flu, he could rest safely at home while the students could listen without loss to his echo. It suggests possibilities for vacations, etc., etc. I have passed the ball to you; please make a run with it.—F. R. M.

I think you have something in your *suggestion*. I don't know what the cost would be to each college for instruments and personnel capable of running a recording, but I am certain that this method of checking up on ourselves would improve the quality of teaching. I think, however, it should come not from deans and college presidents, but from the faculties as a whole.

Let me give you an experience along this line which shows that even FRM's mind isn't so original after all. Many years ago when a prominent disciple of Freud was on a visit to Chicago propagating the extreme psychoanalysis of 50–150 half-hour sessions with each psychotic patient, with the results and diagnosis, etc., not written up until the end, I raised the question with this doctor, as follows: "How can you possibly remember all the questions you have asked and all the things you have told this patient during this long period of repeated interviews? How will you know that what comes out of the patient's mind at the later interviews was not put there by you in the early interviews? Until this point is settled psychoanalysis will not become a science. Why don't you make a complete record of every interview and by studying these records, we will ultimately know something?" The good doctor shook his head in horror and said, "Those interviews are private and sacred; I would not dream of exposing my patients in the way you suggest."

I think some of our weak brethren in teaching will make similar objections to your suggestion, but I will think about it. I think it is worth thinking about and may be developed. It will, of course, be a shock to many.—A. J. Carlson.

JAMES McKEEN CATTELL

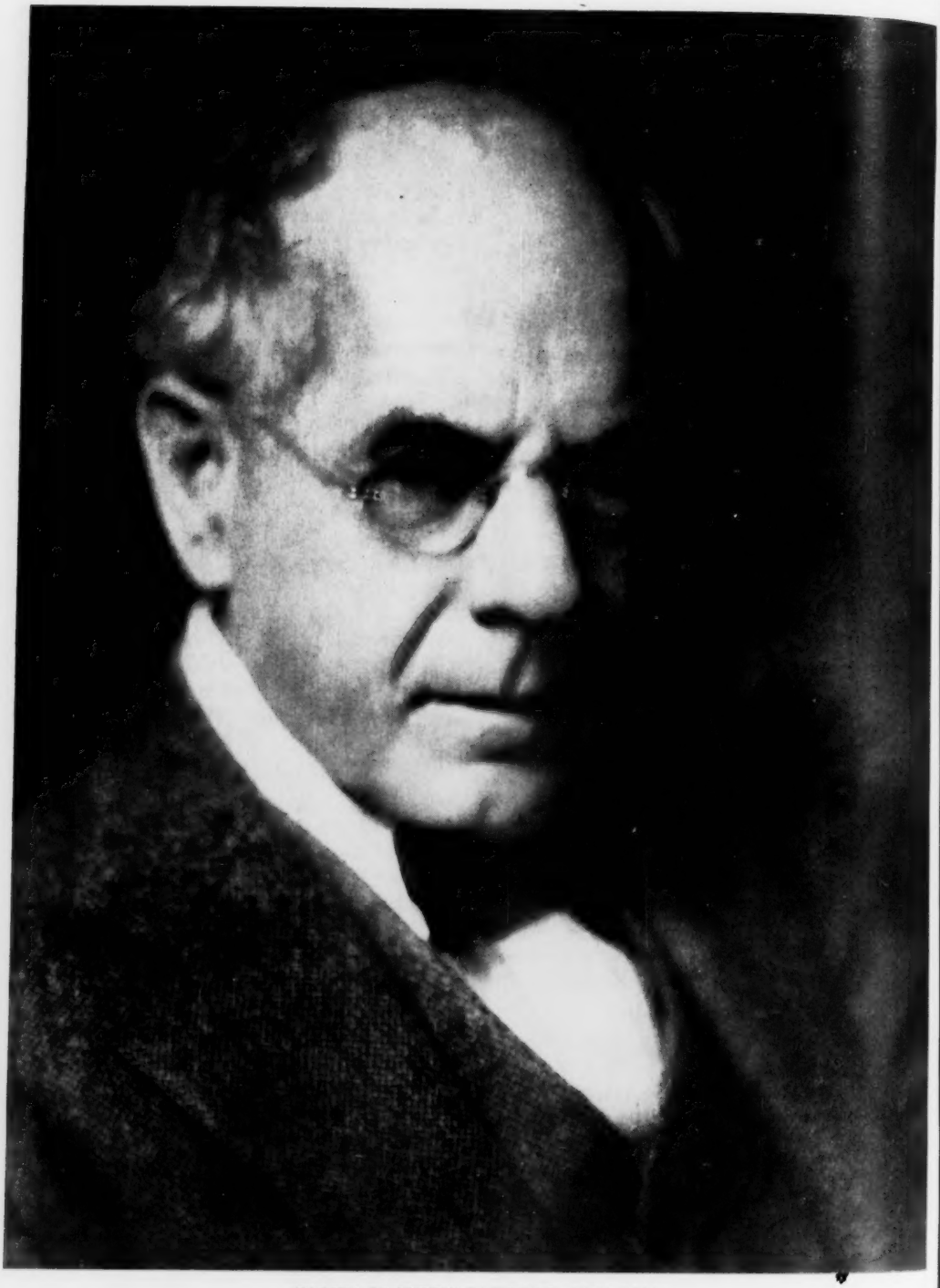
JAMES McKEEN CATTELL was born at Easton, Pennsylvania, on May 25, 1860, and died at Lancaster, Pennsylvania, on January 20, 1944, in his eighty-fourth year. He began life under favorable conditions and reached maturity at the beginning of a transition period in American science. With singleness of purpose and untiring industry he devoted his whole life to the advancement of science, not only in his own field but in every field. If a comprehensive biography of Cattell were written, it would be in considerable part the story of the organization of American science during his lifetime; and if the history of American science and its organization during the past fifty years were written, it would refer frequently to Cattell's influence upon the period. Such statements can be made so truly of very few American scientists.

Cattell's father was the Reverend William C. Cattell, professor of classical languages in Lafayette College and president of the institution from 1863 to 1883. Consequently Cattell grew up in an atmosphere of culture and intellectual integrity. After his graduation from Lafayette College, in 1880, he went to Europe where he remained for seven years, a large part of the time in the laboratory of Wilhelm Wundt, in Leipzig, where he received his Ph.D. degree in 1886. It was fortunate for psychology in America that Cattell studied in Leipzig in this period when Wundt, then near the zenith of his powers, was making of psychology an experimental science. In 1887 he was appointed lecturer, and a year later professor, in psychology in the University of Pennsylvania, where he promptly established a laboratory and instituted courses in experimental psychology.

In 1891 Cattell accepted a call to Columbia University, where he organized a department of psychology and was executive head, also, of the work in anthropology and philosophy. Columbia promptly assumed leadership among American universities in these fields. Cattell was likewise in charge of psychology in Barnard College and was one of the first professors in Teachers College when it became a part of Columbia University. His academic career closed in 1917 when he was dismissed from Columbia University on the ostensible ground that he committed an act of treason by writing to members of Congress in support of legislation exempting from combatant service in Europe those who had conscientious scruples against engaging in war. Cattell brought legal action against Columbia for libel, but the suit was withdrawn upon the agreement by the University to pay him a substantial annuity.

This difference between Cattell and Columbia University had, of course, an important influence on his life, but it is of interest here primarily because it throws a strong light on one of his characteristics. The difference arose because his conscience and judgment required him to take an unpopular position respecting forcing citizens of the United States to bear arms in foreign lands. In taking this stand he placed his principles above what appeared to be to his advantage and stood by them inflexibly. Without judging of the merits of the particular issue, one can only admire Cattell's unyielding defense of what he believed to be right. It has been charged, perhaps with some justice, that he enjoyed a fight, but his disagreements with other men were on questions of principle and policy, rather than on personal matters. Like all strong men, he had definite convictions and stood by them. Like all wise men, he listened to the opinions of others and based his conclusions on the evidence as he understood it. Like all socially mature men, he realized that human interests are often conflicting and that compromises are necessary. Like all other men, he doubtless at times made mistakes—let the man who has not done so cast the first stone.

Cattell was a scientist, and as a scientist his influence was greatest and will live longest. He carried out many researches, he inspired others to engage in scientific research, and as a scientific statesman he served science as a whole. Although these various activities grew out from the same roots, the blossoming and fruits were apparently so independent of one another that they may be considered separately.



JAMES McKEEN CATTELL, 1860–1944

Cattell's researches in psychology began within two years after he became a student of Wundt in Leipzig, in 1883. He published three important papers in 1885 which reflected the influence of his environment, for in them he approached psychology as an experimental science, not one in which the mind turns on itself and pursues itself and its reflections through the obscure labyrinths of consciousness. The following year (1886) he published four papers, all on experimental determinations of the physiological aspects of human mental activities. His series of five papers on "The Time Taken up by Cerebral Operations" filled seventy-two pages of the journal *Philosophische Studien;* they were printed in *Mind*. In 1887 he published but one research paper, for this was a year of travel and of his appointment to a position in the University of Pennsylvania. In 1888 he went to England and lectured at Cambridge University at which he opened a psychological laboratory. This was the year he had the good fortune to marry Josephine Owen of London. In this year also he published a research paper in the German *Philosophische Studien*. During this period he published fourteen principal papers.

After Cattell went to Columbia, in 1895, he worked more and more through his associates and students. He published several papers jointly with others, he introduced his students to his methods and inspired them with his ideals. He said a few years ago that more than 150 members of the American Psychological Association received their Ph.D. degrees at Columbia University. Among those who remained at Columbia as professors and gave this institution leadership in the fields of the mental sciences are Edward L. Thorndike, R. S. Woodworth, H. L. Hollingworth, A. T. Poffenberger, and Arthur I. Gates. With such men carrying forward researches along many lines, Cattell turned more and more to writing briefer reports and digests of his previous work and the work of others, reviews of books, addresses, and expository articles on psychology and science in general. Several of them were published in *Science* and *Popular Science Monthly*, later *The Scientific Monthly*. We find in his bibliography such titles as "The Progress of Psychology" (1893), "The Rise of Psychological Teaching" (1895), "On the Distribution of Exceptional Ability" (1895), "Science in America" (1896), "The Advance of Psychology" (1898), "The University President" (1901), "Concerning the American University" (1902), "The Conceptions of Psychology" (1904), "Examinations, Grades and Credits" (1905), "The American College" (1907), "The School and the Family" (1909), "Doctorates Conferred by American Universities" (1911), "Science and International Good Will" (1908), "A Program of Radical Democracy" (1912), "University Control" (1913), "Science, Education and Democracy" (1914), "Democracy in University Administration" (1914), "Scientific Journals and the Public" (1915), "Science and National Welfare" (1915), "The Organization of Scientific Men" (1922), "Conflicting Moral Imperatives" (1924), "Scientific Research in the United States" (1926), "Psychology in America" (1929), "Education Under the National Government" (1931), and "A Scientific Approach to Emotional Problems" (1934). In addition to these articles he published two books, *University Control* in 1913, and *Carnegie Pensions* in 1919.

A number of the titles of papers and addresses that have been quoted show that as the years passed Cattell became more and more interested in the effects of science upon society and in general methods of advancing it. Early in his scientific life he realized the importance of scientific journals. As early as 1895, he acquired the weekly journal *Science*, established in 1883 by Alexander Graham Bell, which had run continued deficits and was about to discontinue publication. In spite of initial financial losses, he improved its quality and in 1900 it was made the official journal of the American Association for the Advancement of Science. He and Mrs. Cattell edited and maintained high standards for this journal for nearly fifty years. In that time they prepared the manuscripts for publication, read the proofs, arranged the material for the printing of over 2500 issues of *Science*, containing about 60,000 pages of type. Only those who have done editorial work conscientiously can

realize the immense and lifelong drudgery that Dr. and Mrs. Cattell endured in editing *Science*. But this is only a part of the work of the kind that they did. In 1900 Dr. Cattell acquired *The Popular Science Monthly* (since 1908 *The Scientific Monthly*) which he controlled until the spring of 1943 when it was transferred to the American Association for the Advancement of Science. In 1906 he began publishing at about five-year intervals *American Men of Science*, the seventh edition of which will contain biographical sketches of about 34,000 scientists and is about to appear from the press. In 1908 he assumed control of *The American Naturalist*, and in 1915 he established the weekly educational journal *School and Society*.

Cattell was also prominent in scientific organizations, having been a member of the National Academy of Sciences, the American Academy of Arts and Sciences, the American Philosophical Society, the American Association for the Advancement of Science, of which he was president in 1924, and several professional societies. His influence was important in every society in which he took an interest. For about forty years he was the dominant figure in the American Association for the Advancement of Science, publishing its official journal, establishing its business procedures, guiding its policies, and nominating its principal administrative officers. Although many men contributed to the success of the Association during this period, Cattell was the only one who gave it continuous attention for more than forty years. In a very real sense he was a scientific statesman, seeing clearly the great new forces at work in the world, organizing and directing them wisely for the benefit of society, and supporting similar activities by other men.

There was another side to Cattell besides that of conducting and stimulating research, founding, editing and publishing journals and playing important roles in organized science. Early in his career he established his home on an isolated mountain top overlooking the Hudson River. There his children grew up. There he looked up at the glories of the stars at night and down at the glories of the trees by day, particularly in spring and autumn. Below he saw the sunshine and sometimes the fog on the river in the valley, and sometimes, in winter, he looked down on a pure white world and thousands of his Christmas trees sparkling with jewels. That he should have established and maintained such a retreat shows a side of his nature known to but few, for he did not display emotions so sacredly personal. Who can say that he really understood Cattell and who can explain the origin of his great abilities and his tireless use of them for the advancement of science?—F. R. M.

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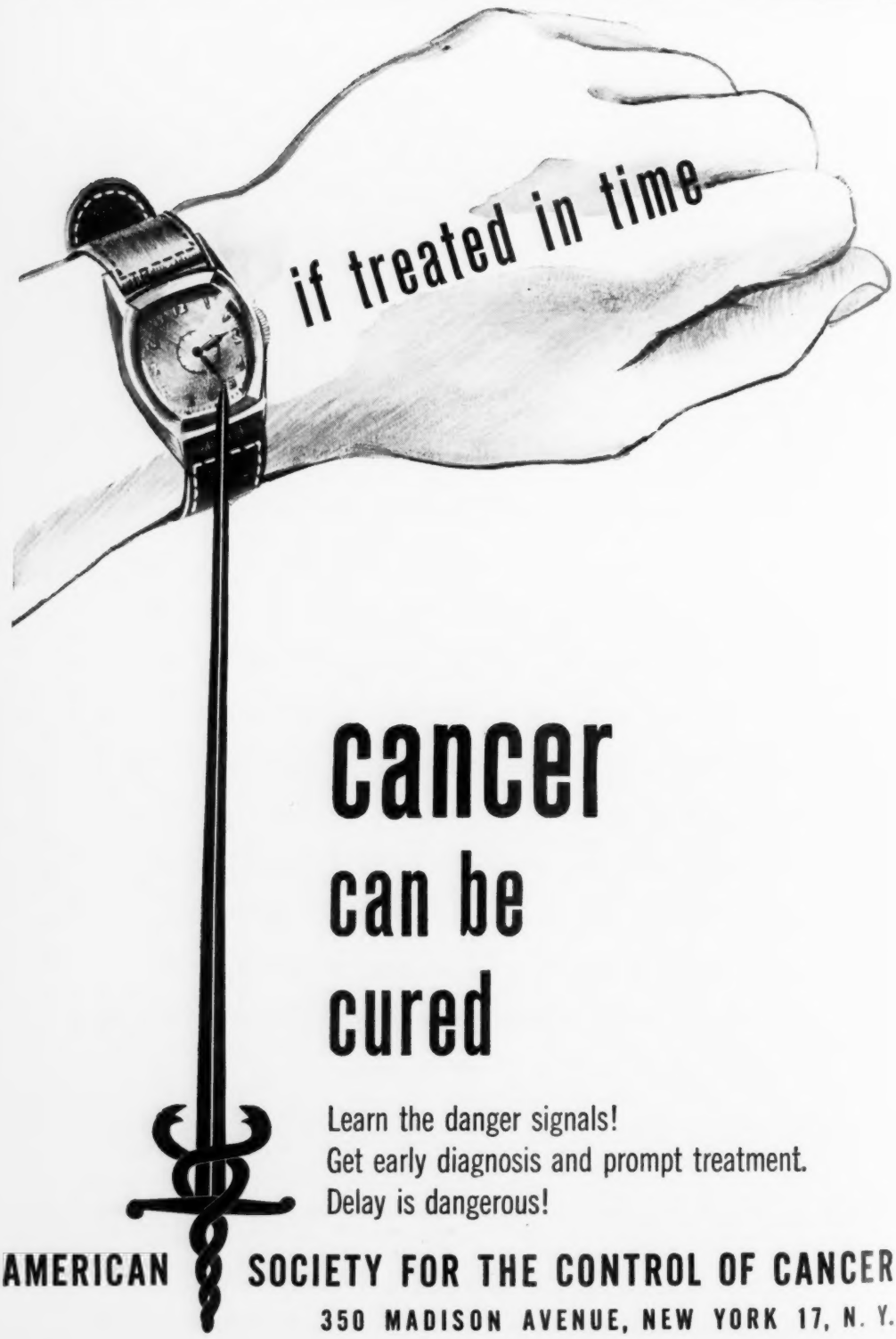
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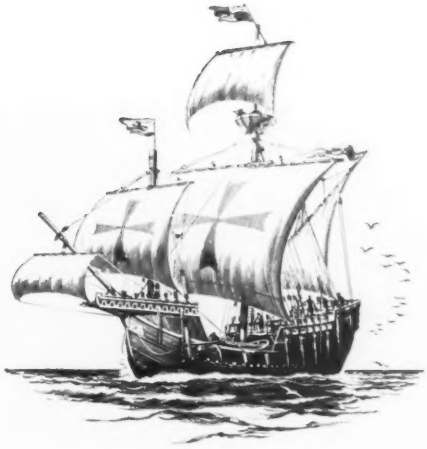

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